

AD-A145 767 THE LONG TERM UPPER OCEAN STUDY (LOTUS) CRUISE SUMMARY  
AND HYDROGRAPHIC D. (U) WOODS HOLE OCEANOGRAPHIC  
INSTITUTION MA E T MONTGOMERY ET AL. JUL 84 WHOI-84-26  
UNCLASSIFIED N00014-76-C-0197 F/G 8/10

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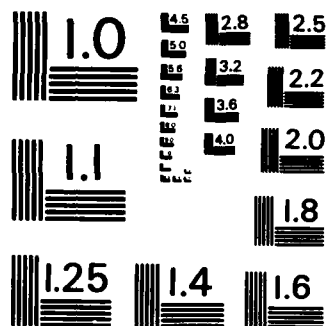
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**Woods Hole  
Oceanographic  
Institution**



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**The Long Term Upper Ocean Study  
(LOTUS)**

**Cruise Summary and Hydrographic Data Report**  
**OCEANUS 141, October 1983**  
**and**  
**OCEANUS 145, January 1984**

by

**Ellyn T. Montgomery, Nancy J. Pennington  
and Melbourne G. Briscoe**

July 1984

**Technical Report**

*Funding was provided by the Office of Naval Research under  
Contract No. N00014-76-C-0197, NR 083-400, and N00014-84-C-0134, NR 083-400.*

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***N. P. Fofonoff***

**Nick P. Fofonoff, Chairman  
Department of Physical Oceanography**

## ABSTRACT

OCEANUS cruises 141 (28 October-4 November 1983) and 145 (22-29 January 1984) were the tenth and eleventh cruises to the Long Term Upper Ocean Study (LOTUS) area centered at 34°N, 70°W. During OCEANUS 141, a C. S. Draper Labs profiling current meter (PCM) was set, the fifth LOTUS surface mooring was recovered, and the deployment of the sixth LOTUS surface mooring was unsuccessfully attempted. The sixth surface mooring was finally deployed in January, on OCEANUS 145. This report provides details of the work accomplished on both cruises, as well as presenting the hydrographic data collected.

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## TABLE OF CONTENTS

	Page
LIST OF FIGURES .....	4
LIST OF TABLES .....	6
ACKNOWLEDGEMENTS .....	7
PART I:	
Introduction .....	8
Cruise Summary: OCEANUS 141 .....	13
Cruise Summary: OCEANUS 145 .....	14
CTD Data Format and Presentation .....	18
PART II: Hydrographic Data OCEANUS 141 .....	20
a. CTD Data .....	21
b. XBT Data .....	30
PART III: Hydrographic Data OCEANUS 145 .....	36
a. CTD Data .....	37
b. XBT Data .....	54
REFERENCES .....	58
APPENDIX I: Chronological Log of OCEANUS cruise number 141 ...	59
APPENDIX II: Chronological Log of OCEANUS cruise number 145 ...	66

## LIST OF FIGURES

Figure Number	Page
1. Chart showing the LOTUS area in the Western North Atlantic	10
2. A chart showing the locations of the LOTUS moorings following OCEANUS cruise 145.	15
3. Mooring diagrams of the four LOTUS moorings in place following OCEANUS 145, plus the surface mooring recovered during OCEANUS 141.	16
4. Chart of the LOTUS area showing the location of the CTD/IR stations made during OCEANUS 141.	22
5. CTD station 1 - OCEANUS 141. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 750 meters and for the entire cast.	24
6. CTD station 2 - OCEANUS 141. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 750 meters and for the entire cast.	26
7. CTD station 3 - OCEANUS 141. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 750 meters and for the entire cast.	28
8. Chart showing the location of individual XBTs taken during the trip south on OCEANUS 141.	31
9. XBT section from southbound trip along 70°W between 40°N and 34°N on OCEANUS 141.	32
10. Chart showing the locations of individual XBT's taken during Leg 2 of OCEANUS 141.	33
11. XBT section from the northbound trip from Bermuda to approximately 34°N, 70°W, on Leg 2 of OCEANUS 141.	34
12. An overplot of all the XBTs taken in the LOTUS area during OCEANUS 141.	35
13. Chart of the LOTUS area showing the location of the CTD/IR stations made during OCEANUS 145.	38

## LIST OF FIGURES (continued)

Figure Number		Page
14.	CTD station 1 - OCEANUS 145. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 750 meters and for the entire cast.	40
15.	CTD stations 2, 3 and 4 - OCEANUS 145. Profiles shown for each station of potential temperature and salinity, and Brunt Väisälä frequency and potential density for approximately the upper 200 meters.	42
16.	CTD station 5 - OCEANUS 145. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 750 meters and for the entire cast.	44
17.	CTD station 6 - OCEANUS 145. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 750 meters and for the entire cast.	46
18.	CTD station 7 - OCEANUS 145. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 400 meters.	48
19.	CTD station 8 - OCEANUS 145. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 750 meters and for the entire cast.	50
20.	CTD station 9 - OCEANUS 145. Profiles of potential temperature and salinity, and Brunt Väisälä frequency and potential density for the upper 750 meters and for the entire cast.	52
21.	Chart showing the location of individual XBTs taken during the trip south on OCEANUS 145.	55
22.	XBT section from southbound trip along 70°W between 40°N and 34°N on OCEANUS 145.	56
23.	An overplot of all the XBTs taken in the LOTUS area during OCEANUS 145.	57
A-1.	Cruise track of OCEANUS cruise number 141.	65
A-3.	Cruise track of OCEANUS cruise number 145.	70



## LIST OF TABLES

Table Number	Page
1. Table of LOTUS reports issued/to be issued.	11
2. Offsets between LORAN positions and geographical (satellite) positions.	12
3. A summary of the positions of moorings in the LOTUS area, following OCEANUS cruise 145.	17
4. A summary of the CTD/IR work conducted on OCEANUS cruise 141.	21
5. Listing of CTD data and derived quantities for station 1.	23
6. Listing of CTD data and derived quantities for station 2.	25
7. Listing of CTD data and derived quantities for station 3.	27
8. A summary of the CTD/IR work conducted on OCEANUS cruise 145.	37
9. Listing of CTD data and derived quantities for station 1.	39
10. Listing of CTD data and derived quantities for stations 2, 3 and 4.	41
11. Listing of CTD data and derived quantities for station 5.	43
12. Listing of CTD data and derived quantities for station 6.	45
13. Listing of CTD data and derived quantities for station 7.	47
14. Listing of CTD data and derived quantities for station 8.	49
15. Listing of CTD data and derived quantities for station 9.	51

## ACKNOWLEDGEMENTS

The LOTUS moorings set and recovered during OCEANUS cruises 141 and 145 were designed and prepared and handled at sea by the WHOI Buoy Group, composed of personnel from the Physical Oceanography Department and the Ocean Structures and Moorings Section of the Ocean Engineering Department.

We are grateful for the skill of Captain Paul Howland and the personnel of the R/V OCEANUS. We thank Richard Trask for his help on this report.

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### Introduction

The main purpose of OCEANUS cruises 141 (Leg 1) and 145 was to replace the Long Term Upper Ocean Study (LOTUS) surface mooring located in the vicinity of 34°N, 70°W, as a continuation of the two year long LOTUS field program (Briscoe and Weller, 1984). Adverse weather conditions on Leg 1 of OCEANUS 141 contributed to damage of the surface mooring discus buoy and meteorological sensors, and the Waverider buoy during deployment. The gear was brought back to Woods Hole, repaired, and subsequently deployed on OCEANUS 145.

Figure 1 shows the LOTUS area (33°-35°N, 69°-71°W) relative to the Gulf Stream, the east coast of the United States and Bermuda. The site is in the mid-ocean away from the direct influences of topography and the Gulf Stream, in the path of hurricanes and Gulf Stream rings and at the edge of the region of eighteen degree water formation and high eddy kinetic energy.

The deployment of the moored array during OCEANUS 141 was to have been the fourth and final science deployment planned for the LOTUS experiment. OCEANUS 145 became the actual final science deployment of the LOTUS project. The first science deployment, designated LOTUS-3, occurred in May 1982 and consisted of a surface mooring, a near-surface mooring and two subsurface moorings. Details of that deployment can be found in Trask and Briscoe (1983a). The LOTUS surface mooring is replaced every six months whereas the near-surface and subsurface moorings are replaced once a year. In October-November 1982 the surface mooring deployed in May was replaced by a nearly identical surface mooring which was designated as LOTUS-4 (Trask and Briscoe, 1983b). In May 1983 the entire moored array was replaced (Trask and Briscoe, 1983c). In early November 1983, the surface mooring, LOTUS-5, was scheduled to be replaced with LOTUS-6. Due to the aforementioned damage to the discus buoy, LOTUS-5 was recovered on OCEANUS 141, but the new surface mooring (LOTUS-6) was not deployed until January 1984, on OCEANUS 145.

This data report summarizes the mooring work, CTD and XBT stations conducted on OCEANUS cruises 141 and 145. The two cruises are here presented together. The format of this report gives a general overview of the work of the two cruises, and presents the hydrographic data separately for each cruise. Thus, the report has three sections: one including information pertaining to both cruises; the second containing all the hydrographic data from Leg 1 of

OCEANUS 141 and the XBT data from Leg 2; and the third with all the hydrographic data from OCEANUS 145.

Table I gives the nominal contents and publication dates of the entire LOTUS report series.

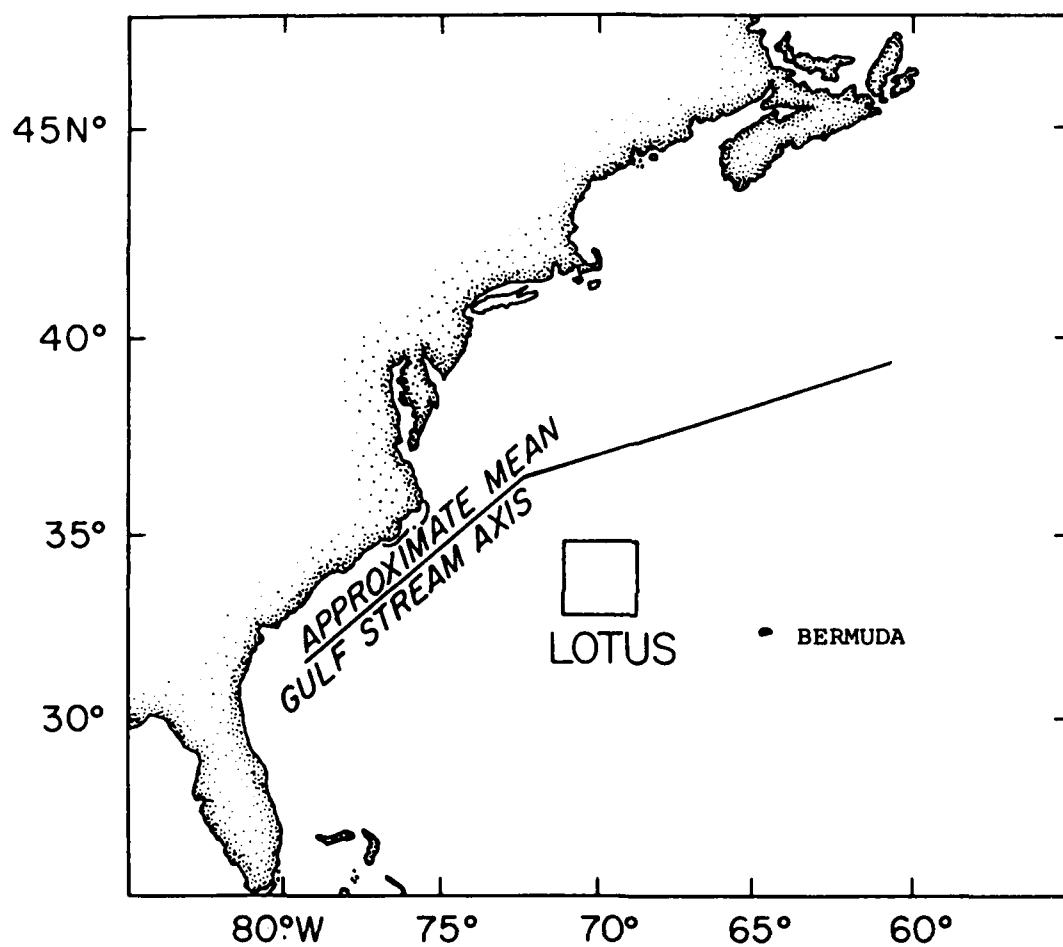


Figure 1. The location of the Long Term Upper-Ocean Study (LOTUS) area.

Table 1. LOTUS-related WHOI Technical Reports.

## PRESENTLY AVAILABLE REPORTS

Title	WHOI No.	Date
Long Term Upper Ocean Study (LOTUS) A Summary of the Historical Data and Engineering Test Data.	82-53	Dec 82
The Long Term Upper Ocean Study (LOTUS) Cruise Summary and Hydrographic Data Report, OCEANUS 119 - May 1982.	83-7	Feb 83
The Long Term Upper Ocean Study (LOTUS) Cruise Summary and Hydrographic Data Report, OCEANUS 129, Oct 1982.	83-29	Aug 83
Long Term Upper Ocean Study (LOTUS) at 34°N, 70°W Meteorological Sensors, Data, and Heat Fluxes for May-October 1982 (LOTUS-3 and LOTUS-4).	83-32	Sept 83
The Long Term Upper Ocean Study (LOTUS) Cruise Summary and Hydrographic Data Report, ENDEAVOR 97, April 1983.	83-33	Oct 83
* The Long Term Upper Ocean Study (LOTUS) Cruise Summary and Hydrographic Data Report, OCEANUS 141, November 1983, and OCEANUS 145, January 1984.	84-26	June 84

## PLANNED FUTURE REPORTS

Subject	Expected Availability
Current meter data report, LOTUS-3 and 4.	Summer 84
Meteorological data report, LOTUS-5 and LOTUS-6.	Fall 84
Cruise summary and hydrographic data report, May 84.	Summer 84
Current meter data report, LOTUS-5 and 6.	Fall 84
A summary of the LOTUS experiment.	Winter 85

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\* This report.

## Navigation

During OCEANUS 141 and 145 two systems of navigation, both based on LORAN C, were utilized. Positions from the more conventional system which has been used during previous LOTUS cruises are based on the geographical calculation performed by the Northstar 7000 LORAN-C unit. The second system uses only the time delays from the Northstar 7000 unit. A position is determined by an independent geographical calculation which makes use of a knowledge of the additional secondary phase factors for the LOTUS area and the transit region. The calculation is performed by a Hewlett-Packard 85 desk top computer, thus the second system has been termed NAV85. A small program error was found in the system on OCEANUS 141, and corrected in time for use on OCEANUS 145; the error gave NAV85 position offsets if the ship was steaming full-ahead. The system functioned properly on the latter cruise, but no detailed study has been made of the accuracy of the system. Therefore the NAV85 continues to be in the development stage. All positions shown in this report are based on the geographical calculation performed by the Northstar 7000 LORAN-C unit.

The Northstar algorithm provides a geographical position that is south-east of the true (satellite based) position. From numerous simultaneous position fixes in the LOTUS area we have determined an average offset of the LORAN-based calculation. Table 2 shows the offsets and standard deviations for the Northstar 7000. Positions listed in Tables and Figures in this report are all the Northstar 7000 positions; to convert to absolute geographical positions the offsets shown for the Northstar 7000 in Table 2 should be added.

Table 2. Offsets (and standard deviations) from LORAN position to geographical position, based on simultaneous LORAN and satellite position fixes (GEOG = LORAN + OFFSET).

UNIT	OFFSET (S.D.)		OFFSET (S.D.)	
	North	West	Range [km] *	Bearing
Northstar 7000	1.07' (.15)	1.24' (.16)	2.76' (.32)	316° (4)

\* 1 km = .54 nautical miles.

## Cruise Summary

## OCEANUS 141

October-November 1983

Leg 1 of R/V OCEANUS Cruise 141 was the tenth scheduled cruise to the LOTUS area, centered at 34°N, 70°W. The cruise was eight days long, ending in St. Georges, Bermuda.

The LOTUS surface mooring, designated "LOTUS-5" (mooring number 787) was recovered during the cruise. Subsequently, the deployment of the surface mooring to replace LOTUS-5 was attempted. Unfortunately, a quick release hook malfunctioned, dropping the discus buoy during deployment, and damaging the tower and meteorological sensors significantly enough to warrant canceling the deployment. The redeployment of the surface mooring was planned for January 1984 (see cruise summary for OCEANUS 145).

Since the new surface mooring (mooring number 791) was not deployed, a trial of the internally recording and telemetering Datawell Waverider buoy, which was to have been tethered to 791, was planned. While the Waverider was tethered to the ship, a squall pushed the ship over the tether line, and fouled the tether in the ship's propeller. Approximately eight hours later the Waverider was sighted and recovered, revealing that the encounter had broken its radio antenna and light, and done structural damage to the sphere itself. The Waverider was replaced in time for re-deployment with the new surface mooring in January.

Other mooring work completed in the LOTUS area on OCEANUS 141 (Leg 1) involved the setting of a C.S. Draper Labs profiling current meter (PCM) mooring, in cooperation with C. Eriksen of MIT. Mooring work outside the LOTUS area consisted of the recovery of a surface mooring in the Gulf Stream (37°36.94'N, 68°00.07'W) for H. Bryden's Gulf Stream Observation (GUSTO) project.

Non-mooring work on this cruise consisted of calibration trials of the Acoustic Profiling of Ocean Currents (APOC) system, which was run nearly continuously on Legs 1 and 2.

XBT sections were made during Legs 1 and 2 of this cruise. Both sections are presented in this data report, although no other information from Leg 2 is included, because the XBT data was collected for this project on an otherwise unrelated trip. As well, three CTD stations were completed on Leg 1 of OCEANUS 141; details of the XBT and CTD work are presented in Part II of this report. A chronological log of OCEANUS 141 along with a plot of the cruise track appear in Appendix 1.



## Cruise Summary

OCEANUS 145

January 1984

Cruise number 145 of the R/V OCEANUS was the eleventh cruise to the LOTUS area ( $34^{\circ}\text{N}$ ,  $70^{\circ}\text{W}$ ). The cruise departed Woods Hole on 22 January, and returned seven days later on 29 January.

During this cruise, a new surface mooring (mooring number 792) was successfully deployed. This mooring is designated LOTUS-6. The Datawell internally recording and telemetering Waverider buoy was also successfully deployed, with its tether attached to the discus buoy of 792. The output of the Waverider was monitored from the ship, with observations made regarding corresponding sea state and wind speeds. Other mooring work in the LOTUS area consisted of doing acoustic surveys of the newly set surface mooring (792), the subsurface mooring (788), and the east (789) and south (790) intermediate moorings.

The location of each of the moorings and the C.S. Draper Labs/MIT Profiling Current Meter (PCM), following OCEANUS 145, are shown in Figure 2. Mooring diagrams, including LOTUS-5 (787, recovered November 1983) and LOTUS-6 (792, deployed January 1984), are shown in Figure 3. The instrument depths shown in Figure 3 are design depths; actual depths may vary slightly. Table 3 summarizes the mooring deployment times and positions.

Non-mooring work in the LOTUS area involved the following; doing several tests of the Weller-Dean Real Time Profiler (RTP); performing two anchor drag trials, to determine the horizontal force required to move a mooring's anchor; and attempting (unsuccessfully) to take cores of the bottom material in the LOTUS area.

An XBT section was made on the trip south, and nine CTD casts were made in the LOTUS area. Details of the XBT and CTD work from this cruise are presented in section III of this report. A chronological log of OCEANUS 145, along with a plot of the cruise track appear in Appendix II.

LOTUS MOORINGS  
JANUARY 1984

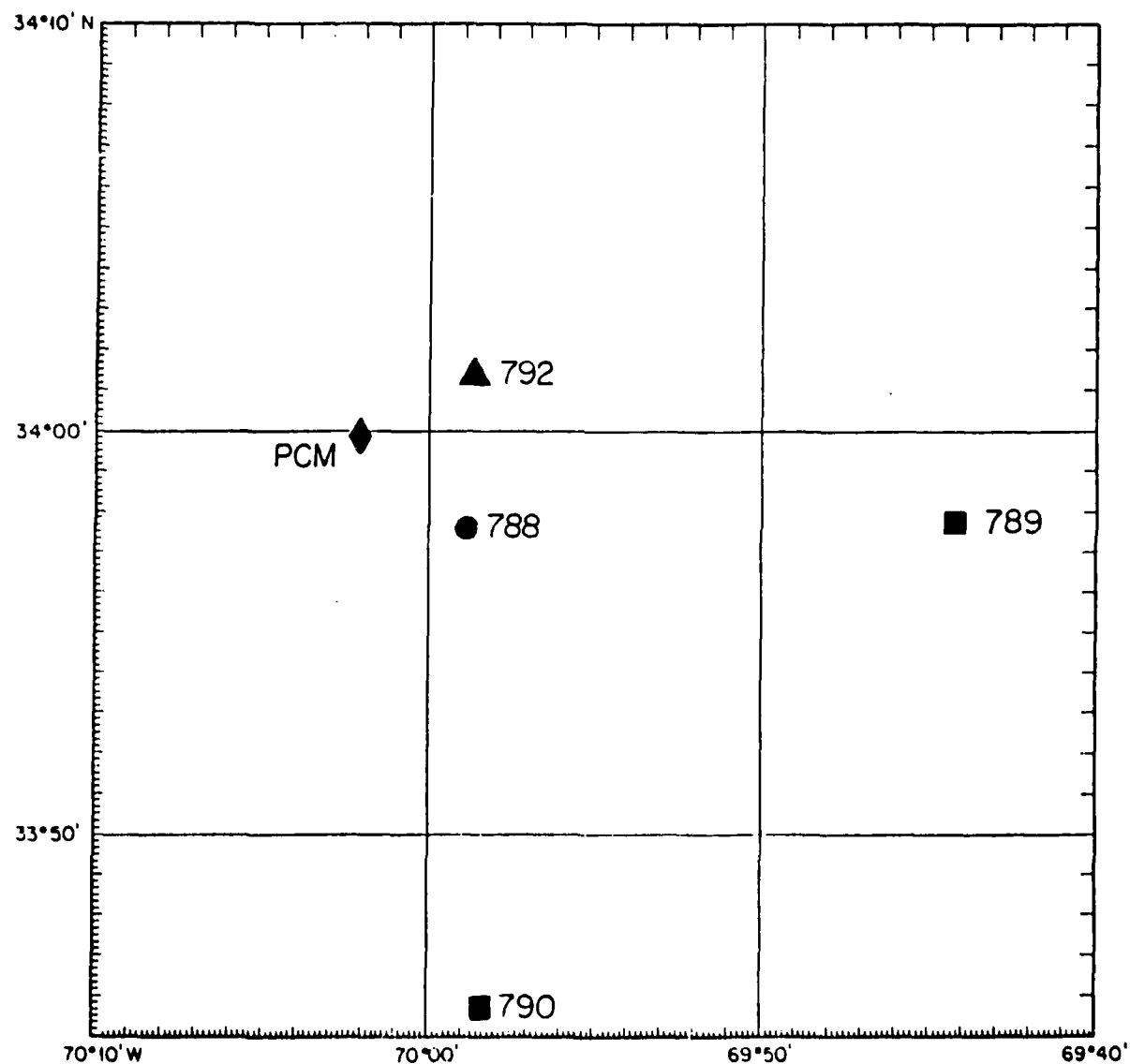


Figure 2. A chart of a section of the LOTUS area showing the location of the LOTUS-6 surface mooring ( $\blacktriangle$ ), near-surface mooring ( $\bullet$ ), subsurface moorings ( $\blacksquare$ ) and PCM ( $\blacklozenge$ ) following OCEANUS cruise 145.

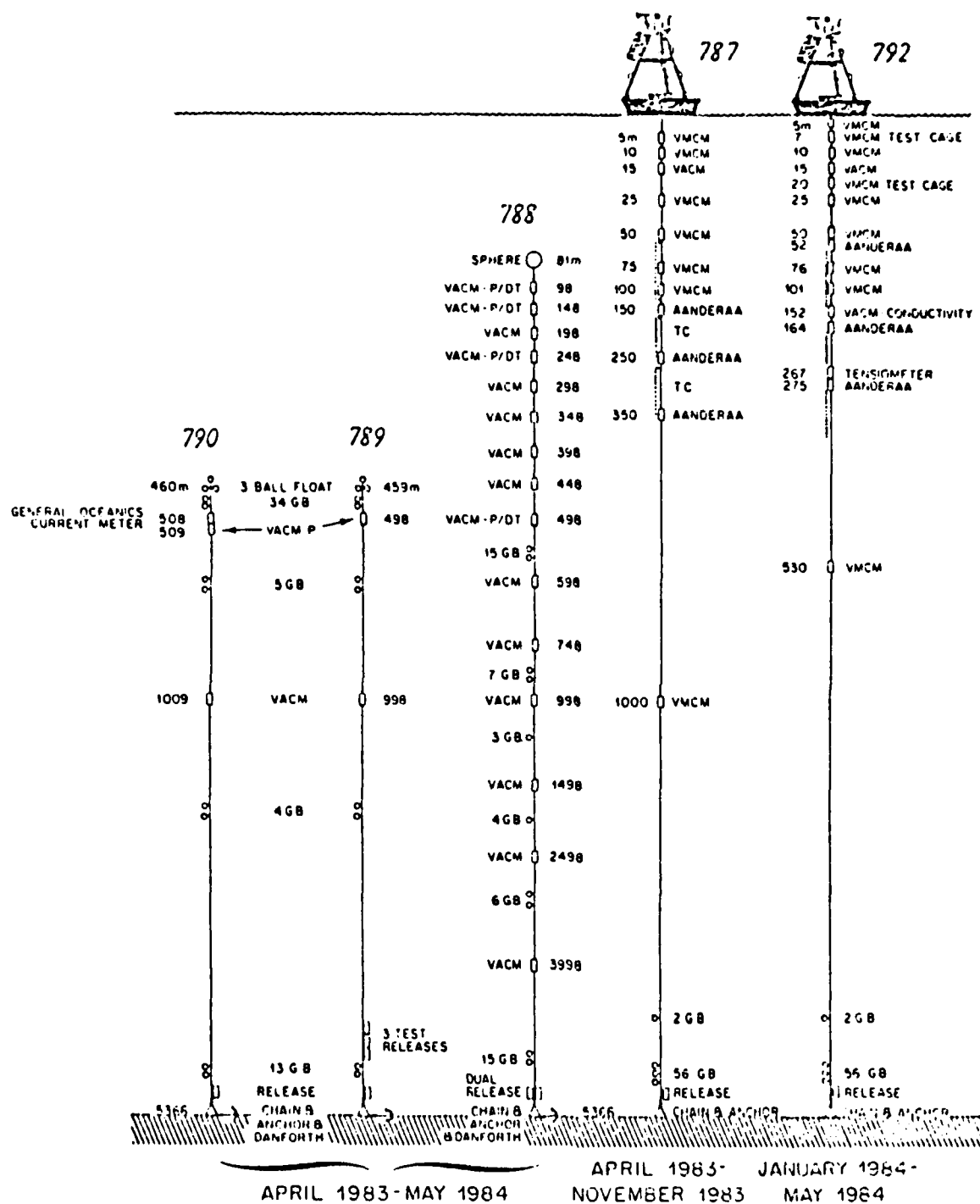


Figure 3. Mooring diagrams of the four LOTUS moorings in the LOTUS area following OCEANUS 145, as well as the surface mooring (787) recovered on OCEANUS 141.

Table 3. A summary of the positions of the moorings (in the LOTUS area) following OCEANUS 145.

Mooring ID	Date/Time Set	LORAN-C Anchor Position	
792 LOTUS-6 Surface Mooring	20 January, 1984/2200Z	34°01.23'N	69°58.76'W
788 LOTUS-5 Near-surface	13 April 83/0447Z	33°57.63'N	69°58.76'W
789 LOTUS-5 East Intermediate	14 April 83/2041Z	33°57.33'N	69°44.36'W
790 LOTUS-5 South Intermediate	15 April 83/1740Z	33°45.53'N	69°58.86'W
PCM-Zeta MIT-Draper Labs Profiling Current Meter	3 November 83/0113Z	33°59.93'N	70°02.16'W

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## CTD Data Format and Presentation

The following is a brief discussion of calibration and preliminary processing procedures used in our CTD work.

### Data Presentation

The CTD/IR data are presented in two forms, tabular listings and graphical profiles. The profiles are reproductions of the original computer plots. Included here are profiles of potential temperature, salinity, Brunt Väisälä frequency, and potential density referenced to the surface (Figures 5-9). Full depth profiles as well as profiles of the upper 750 meters are presented. In addition a potential temperature-salinity diagram is presented for each station. The listings of data (Tables 5-9) include the above parameters plus sigma-t, potential temperature gradient, dynamic height, and sound speed, all at standard pressures as well as at the design depths of the instrumentation on the moorings.

The heading of the tabular listing includes the ship name (OC = OCEANUS) and cruise number, CTD number, year, year day, time, the latitude and longitude (LORAN-7000 position) of the CTD station when it started and the water depth at that station. Abbreviations used in the listings include PRESS for pressure, TEMP for temperature, SALIN for salinity, PTEMP for potential temperature, POTGRD for potential temperature gradient, POTDEN for potential density, BR-V for Brunt Väisälä frequency, SSPEED for sound speed and DYNHGT for dynamic height.

### Summary of Calibration and Data Processing Procedures

The CTD/IR routinely undergoes pre-cruise laboratory calibrations at WHOI. The laboratory calibration of the temperature and pressure sensors is relied on totally for adjusting the calibration coefficients of those sensors. The conductivity sensor is calibrated using water samples collected at the bottom of each cast. Based on a comparison of the water sample salinities and the CTD/IR conductivity readings a conductivity cell factor is computed for

each station. The cell factor is the scaling factor by which the measured conductivity must be multiplied to obtain the "true" conductivity. The conductivity values of the entire cast are then multiplied by the appropriate cell factor to obtain the "true" conductivities.

The preliminary CTD/IR data processing is accomplished with a SEA DATA 12A cassette reader and Asynchronous Reader Interface in conjunction with a Hewlett Packard (HP) 85 desk top computer and HP 5.25 inch flexible disc drive, printer and 7225B plotter. The preliminary processing takes the raw down cast data from cassette and applies the appropriate calibration coefficients, edits wild points, applies a pressure and conductivity sensor time lag correction, pressure averages the data (2 dbar pressure range) and stores the data on flexible disc.

All salinity computations are based on the 1978 Practical Salinity Scale (Lewis and Perkin, 1981) as recommended by the Joint Panel on Oceanographic Tables and Standards. Further processing incorporates the new equation of state for sea water (Millero, et al., 1980) for computing density and its related parameters such as specific volume and specific volume anomaly. Potential temperature at a reference pressure is computed using a fourth order Runge Kutta integration algorithm (Fofonoff, 1977) which uses the Bryden (1973) polynomial for adiabatic lapse rate. Sound speed calculations are based on the algorithms of Chen and Millero (1977). These algorithms are the basis of further computations which yield quantities of sigma-t, sigma-theta, dynamic height, potential temperature gradients and Brunt-Väisälä frequency. The Brunt-Väisälä frequency calculation incorporates a sliding least squares fit to the potential density data over user specified smoothing windows. Four windows were chosen for this calculation. A smoothing interval of 10 dbars was used between 0 and 150 dbars, a 30 dbar interval between 150 and 1500 dbars, 62 dbar interval between 1500 and 3500 dbars and a 90 dbar smoothing interval between 3500 dbars and the bottom.

PART II  
Hydrographic Data  
OCEANUS 141  
28 October - 10 November 1983

# A. CTD Data: OC 141

During OCEANUS 141, three CTD stations were made, one at the Gulf Stream Observation (GUSTO) project site, and two in the LOTUS area (Figure 4). The measurements were made by a Neil Brown Instrument Systems internal recording conductivity-temperature-depth profiler (CTD/IR); mechanical and operational details of the LOTUS CTD/IR are found in Trask (1981).

The first station was performed at the GUSTO site (37°36.96'N, 68°00.08'W) immediately prior to the recovery of the mooring. This cast was terminated at 1400 m. Stations 2 and 3 were both in the LOTUS area, and each went to a depth of approximately 5000 m. The second station was done near the south intermediate mooring, and the third near the LOTUS-5 surface mooring location. The positions of these three CTD's are shown in Table 4.

Table 4: A summary of the CTD/IR work conducted on OCEANUS cruise 141.

CTD Station	Date (year day)	Start Time (UTC)	Deployed Position		Pressure Range (dbar)
			Lat. (N)	Long. (W)	
1	29 Oct 83 (303)	1429	37°37.88'	68°02.35'	0-2919
2	1 Nov 83 (305)	1617	33°46.66'	70°01.84'	0-4942
3	2 Nov 83 (306)	1333	34°01.75'	69°59.50'	0-5306



CTD STATIONS  
LOTUS AREA  
NOVEMBER 1983

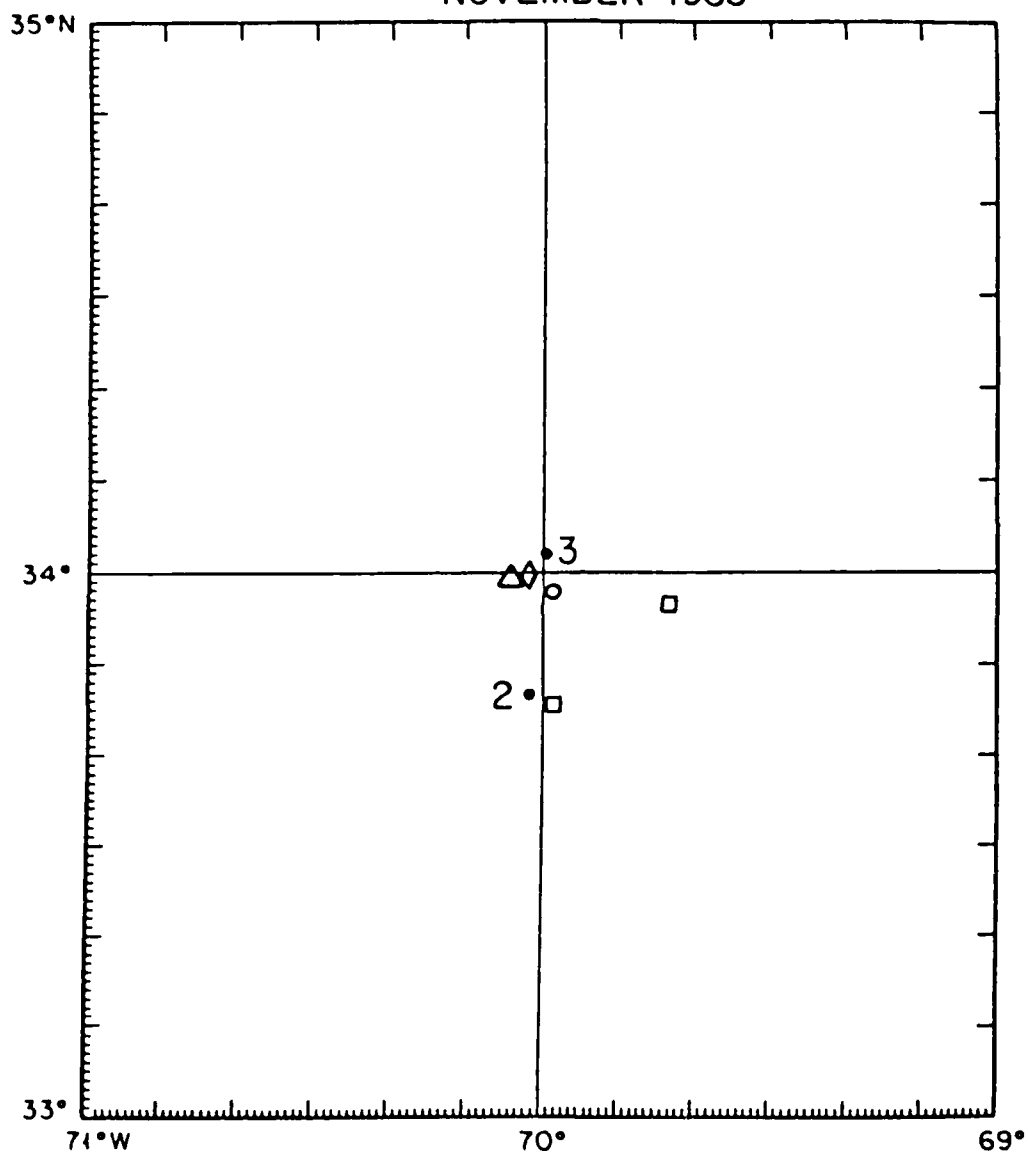


Figure 4. Chart of the LOTUS area showing the locations of the CTD/IR stations (●) made during OCEANUS 141 and their proximity to the LOTUS-5 surface mooring (Δ), near-surface mooring (◐), subsurface moorings (◻), and PCM (◊).

Table 5: Listing of CTD data and derived quantities for station 1.

DC141	CTD 001	1983 303 1430Z	37 37.88N	68 02.35W	corrD: 4693m				
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	22.522	36.267	22.522	0.00	25.051	25.043	0.00	1529.6	0.0000
6.	22.554	36.314	22.553	-4.64	25.077	25.070	2.62	1529.8	.0116
10.	22.560	36.312	22.558	1.30	25.074	25.067	-.98	1529.9	.0231
16.	22.562	36.312	22.559	.26	25.074	25.066	.31	1530.0	.0401
20.	22.563	36.312	22.559	.35	25.074	25.067	.26	1530.1	.0525
26.	22.564	36.312	22.559	.09	25.073	25.067	-.12	1530.2	.0700
30.	22.564	36.312	22.558	.02	25.073	25.067	.36	1530.3	.0806
36.	22.565	36.312	22.558	-.43	25.073	25.066	-.31	1530.4	.0983
50.	22.567	36.313	22.557	-.64	25.073	25.068	-.52	1530.6	.1390
66.	22.572	36.312	22.559	.02	25.071	25.067	.61	1530.9	.1861
76.	22.535	36.328	22.520	12.57	25.093	25.090	10.34	1531.0	.2146
100.	20.308	36.560	20.290	112.17	25.886	25.885	6.29	1525.7	.2726
126.	19.689	36.557	19.666	33.76	26.049	26.049	4.16	1524.4	.3267
150.	19.152	36.549	19.125	12.91	26.183	26.183	3.55	1523.3	.3738
200.	18.725	36.537	18.689	9.09	26.283	26.286	2.13	1522.9	.4659
250.	18.435	36.533	18.392	5.62	26.353	26.358	1.91	1522.9	.5550
300.	18.217	36.522	18.164	2.04	26.400	26.407	1.85	1523.1	.6421
350.	17.934	36.505	17.874	8.65	26.458	26.466	1.98	1523.1	.7283
400.	17.653	36.468	17.584	3.08	26.499	26.510	1.57	1523.1	.8128
450.	17.399	36.432	17.323	3.40	26.534	26.546	1.61	1523.1	.8959
500.	17.081	36.382	16.997	12.32	26.572	26.586	1.68	1522.9	.9779
550.	16.599	36.292	16.509	12.07	26.618	26.633	2.11	1522.2	1.0583
600.	15.920	36.169	15.823	11.84	26.682	26.698	2.18	1520.8	1.1372
650.	14.975	36.003	14.875	17.71	26.768	26.783	2.64	1518.5	1.2126
700.	14.122	35.861	14.018	11.20	26.843	26.858	2.57	1516.5	1.2850
750.	12.983	35.679	12.877	10.88	26.940	26.954	2.65	1513.3	1.3530
800.	12.013	35.545	11.905	24.42	27.028	27.040	2.60	1510.7	1.4174
900.	9.806	35.258	9.699	-5.54	27.205	27.214	2.45	1504.3	1.5320
1000.	7.745	35.089	7.640	61.53	27.402	27.407	3.26	1498.1	1.6283
1100.	6.426	35.077	6.321	1.98	27.578	27.581	2.18	1494.7	1.7040
1200.	5.507	35.044	5.400	10.01	27.670	27.672	1.66	1492.6	1.7664
1300.	4.945	35.019	4.833	7.60	27.718	27.719	1.45	1492.0	1.8222
1400.	4.673	35.010	4.555	4.80	27.742	27.743	1.02	1492.5	1.8746

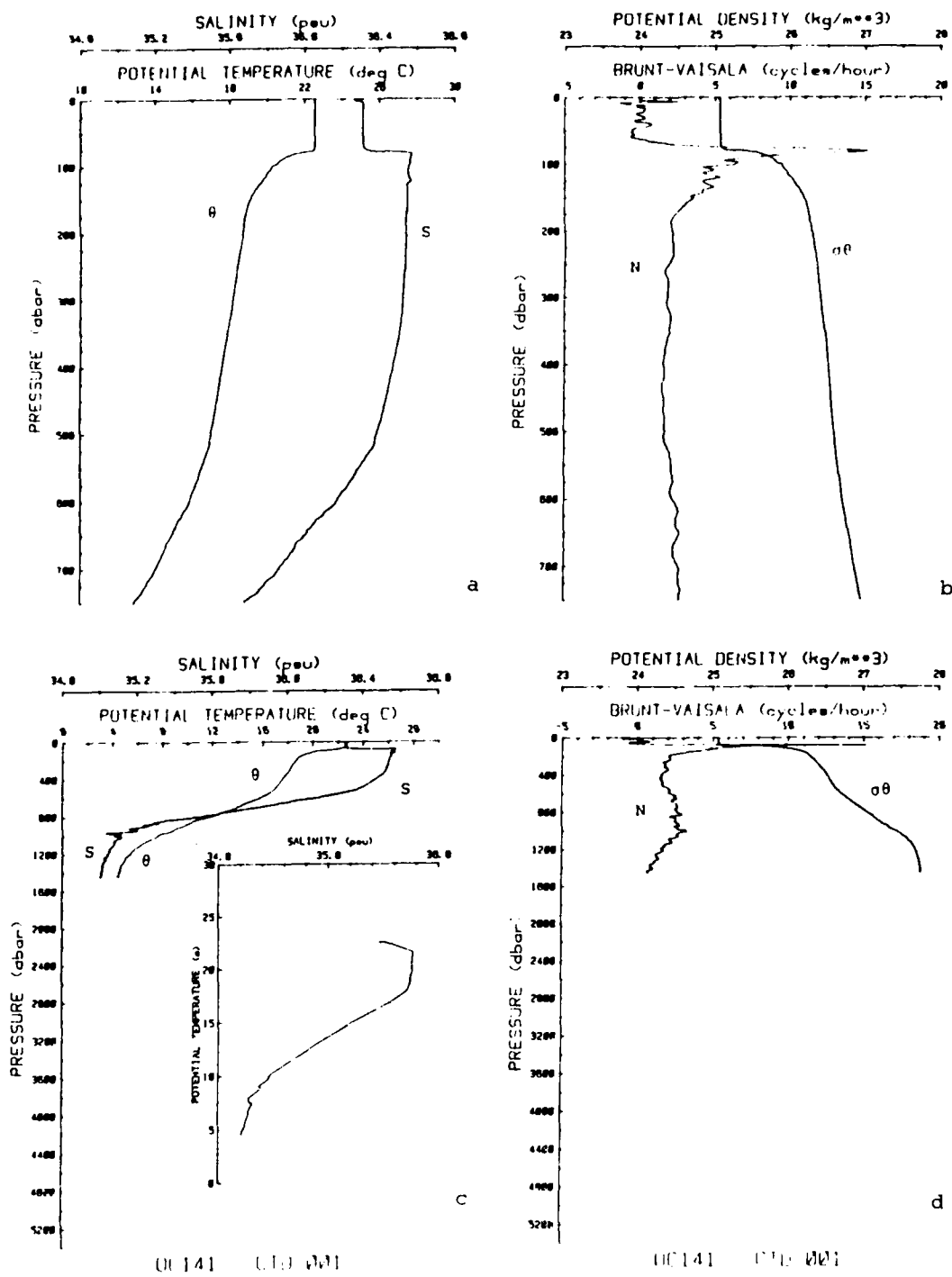


Figure 5. CTD station 1. Profiles of potential temperature ( $\theta$ ) and salinity (S), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) for the upper 750 m (a and b respectively) and for the entire cast (c and d respectively).  $\theta$ -S diagram included in c.

Table 6: Listing of CTD data and derived quantities for station 2.

OC141	CTD 002	1983 305 1602Z	33 46.66N 70 01.84W	corrD: 5366m					
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	23.408	36.282	23.408	0.00	24.806	24.797	0.00	1531.9	0.0000
6.	23.414	36.280	23.413	1.95	24.803	24.795	-.92	1532.0	.0131
10.	23.415	36.279	23.413	-.27	24.802	24.794	.78	1532.1	.0263
16.	23.404	36.278	23.401	1.13	24.804	24.797	.80	1532.1	.0438
20.	23.407	36.279	23.403	-1.38	24.804	24.797	.31	1532.2	.0575
26.	23.403	36.278	23.398	1.64	24.805	24.798	.62	1532.3	.0764
30.	23.405	36.279	23.400	-.76	24.804	24.797	.57	1532.4	.0878
36.	23.392	36.278	23.384	4.65	24.808	24.802	1.44	1532.4	.1078
50.	23.389	36.278	23.379	-.92	24.808	24.803	.63	1532.7	.1521
66.	23.310	36.286	23.297	5.46	24.838	24.833	2.64	1532.7	.2028
76.	22.208	36.527	22.193	249.16	25.337	25.334	14.00	1530.3	.2326
100.	20.828	36.550	20.809	77.77	25.738	25.736	5.66	1527.1	.2907
126.	19.911	36.544	19.888	53.41	25.980	25.980	5.44	1525.0	.3481
150.	19.362	36.537	19.335	10.56	26.119	26.120	3.72	1523.9	.3959
200.	18.789	36.529	18.753	6.93	26.261	26.263	2.40	1523.1	.4901
250.	18.480	36.523	18.436	8.64	26.335	26.339	2.18	1523.1	.5809
300.	18.216	36.515	18.163	5.83	26.395	26.402	1.88	1523.1	.6689
350.	17.943	36.501	17.883	2.50	26.452	26.461	2.01	1523.1	.7540
400.	17.647	36.463	17.579	9.12	26.497	26.507	1.56	1523.1	.8390
450.	17.397	36.425	17.321	6.27	26.529	26.541	1.59	1523.1	.9221
500.	17.088	36.379	17.005	2.13	26.568	26.582	1.51	1523.0	1.0044
550.	16.573	36.285	16.483	13.14	26.619	26.634	1.95	1522.1	1.0852
600.	15.754	36.128	15.659	27.67	26.689	26.704	2.43	1520.3	1.1642
650.	14.795	35.968	14.695	25.86	26.781	26.796	2.78	1517.9	1.2392
700.	13.804	35.815	13.701	-.02	26.876	26.890	1.98	1515.4	1.3098
750.	12.944	35.682	12.838	28.92	26.951	26.964	2.54	1513.2	1.3776
800.	11.721	35.515	11.615	9.44	27.061	27.072	2.84	1509.7	1.4398
900.	9.540	35.240	9.435	20.83	27.236	27.244	2.58	1503.3	1.5508
1000.	7.613	35.116	7.510	15.37	27.443	27.447	2.76	1497.6	1.6432
1100.	6.183	35.075	6.080	-6.30	27.609	27.611	1.98	1493.7	1.7154
1200.	5.559	35.068	5.452	8.03	27.683	27.684	1.41	1492.9	1.7758
1300.	5.145	35.055	5.032	3.29	27.723	27.725	1.29	1492.8	1.8316
1400.	4.729	35.022	4.610	3.32	27.745	27.747	.98	1492.8	1.8840
1500.	4.562	35.022	4.435	-1.60	27.764	27.767	.77	1493.7	1.9351
1600.	4.417	35.018	4.283	3.04	27.777	27.779	.74	1494.8	1.9851
1800.	4.168	35.008	4.017	1.65	27.796	27.800	.73	1497.1	2.0840
2000.	3.947	35.001	3.780	1.22	27.814	27.820	.67	1499.5	2.1811
2200.	3.753	34.993	3.569	.23	27.828	27.834	.69	1502.1	2.2768
2400.	3.552	34.984	3.352	.86	27.841	27.848	.56	1504.6	2.3712
2500.	3.459	34.979	3.251	.48	27.846	27.854	.57	1505.9	2.4179
2600.	3.367	34.973	3.150	.56	27.851	27.859	.57	1507.2	2.4646
2800.	3.180	34.961	2.946	2.98	27.858	27.868	.63	1509.8	2.5570
3000.	2.977	34.948	2.727	.47	27.867	27.878	.63	1512.3	2.6480
3200.	2.813	34.939	2.546	.27	27.875	27.887	.61	1515.0	2.7375
3400.	2.668	34.930	2.383	.58	27.881	27.893	.48	1517.8	2.8257
3600.	2.541	34.922	2.236	1.74	27.886	27.899	.52	1520.7	2.9131
3800.	2.450	34.916	2.126	.37	27.888	27.904	.48	1523.7	3.0000
4000.	2.394	34.911	2.048	1.52	27.889	27.906	.36	1526.9	3.0872
4200.	2.360	34.906	1.993	.19	27.889	27.907	.36	1530.2	3.1755
4400.	2.334	34.903	1.944	.22	27.888	27.908	.36	1533.5	3.2651
4600.	2.323	34.898	1.909	.32	27.885	27.907	.26	1536.9	3.3563
4800.	2.318	34.895	1.880	.13	27.883	27.907	.30	1540.4	3.4494

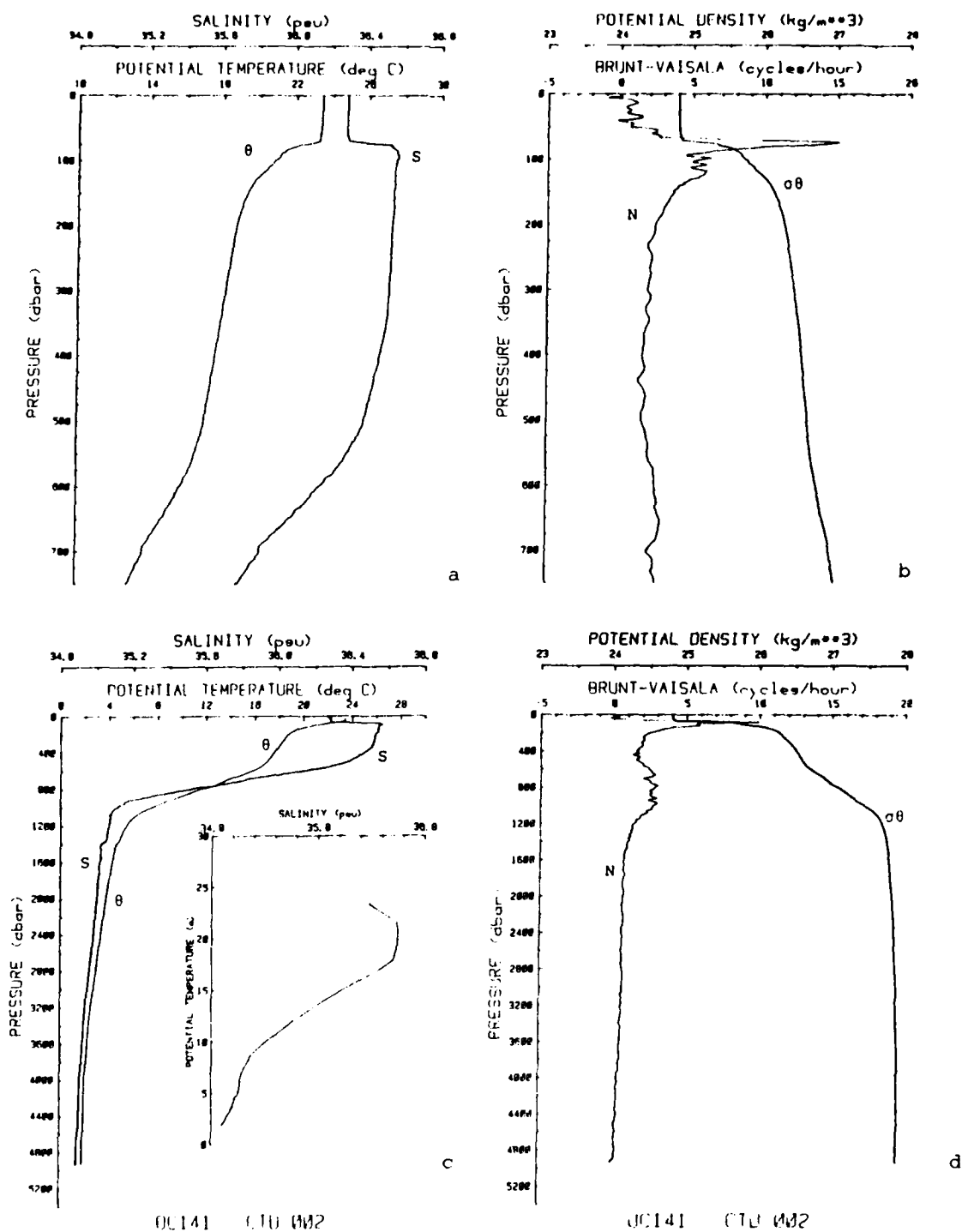


Figure 6. CTD station 2. Profiles of potential temperature ( $\theta$ ) and salinity (S), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) for the upper 750 m (a and b respectively) and for the entire cast (c and d respectively).  $\theta$ -S diagram included in c.

Table 7: Listing of CTD data and derived quantities for station 3.

00141	CTD 003	1983 306 1100Z	34 01.75N	69 59.5W	corrD: 5363m				
FRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	23.104	36.309	23.104	0.00	24.915	24.907	0.00	1531.2	0.0000
6.	23.101	36.309	23.100	1.69	24.916	24.908	.64	1531.2	.9128
10.	23.103	36.308	23.101	-1.28	24.915	24.907	-.47	1531.3	.0252
16.	23.110	36.309	23.107	-2.89	24.913	24.906	-.95	1531.4	.0434
20.	23.108	36.309	23.105	.55	24.914	24.906	.71	1531.5	.0562
26.	23.110	36.309	23.105	-1.09	24.913	24.906	.32	1531.6	.0745
30.	23.109	36.309	23.103	.24	24.914	24.907	-.67	1531.6	.0857
36.	23.115	36.308	23.108	-.98	24.911	24.905	-.48	1531.8	.1042
50.	23.113	36.308	23.104	.27	24.912	24.907	.69	1532.0	.1471
66.	23.021	36.337	23.008	23.85	24.961	24.956	14.31	1532.1	.1955
76.	21.507	36.560	21.492	93.19	25.559	25.556	8.04	1528.5	.2221
100.	20.168	36.551	20.149	25.23	25.917	25.916	5.72	1525.3	.2770
126.	19.597	36.560	19.574	25.57	26.075	26.074	4.49	1524.2	.3303
150.	19.150	36.548	19.124	4.11	26.182	26.183	2.88	1523.3	.3769
200.	18.705	36.528	18.669	9.59	26.281	26.284	2.40	1522.9	.4693
250.	18.466	36.525	18.422	6.55	26.340	26.344	1.83	1523.0	.5583
300.	18.193	36.519	18.141	10.06	26.404	26.411	1.95	1523.1	.6467
350.	17.916	36.503	17.856	6.27	26.460	26.469	1.71	1523.1	.7320
400.	17.664	36.468	17.596	3.86	26.496	26.507	1.54	1523.1	.8162
450.	17.388	36.427	17.312	6.27	26.533	26.545	1.56	1523.1	.8995
500.	17.032	36.370	16.949	3.90	26.575	26.589	1.68	1522.8	.9815
550.	16.482	36.266	16.392	14.51	26.625	26.640	2.33	1521.8	1.0620
600.	15.641	36.113	15.546	20.85	26.703	26.718	2.53	1519.9	1.1399
650.	14.802	35.972	14.702	12.93	26.782	26.797	2.59	1517.9	1.2148
700.	13.610	35.775	13.508	26.95	26.885	26.899	2.69	1514.7	1.2854
750.	12.780	35.657	12.676	23.76	26.964	26.977	2.70	1512.6	1.3521
800.	11.461	35.474	11.357	38.36	27.077	27.088	2.72	1508.8	1.4139
900.	9.352	35.230	9.248	15.4	27.260	27.268	2.60	1502.6	1.5232
1000.	7.349	35.108	7.248	32.30	27.474	27.478	2.66	1496.6	1.6118
1100.	6.178	35.078	6.075	12.26	27.612	27.614	1.89	1493.7	1.6821
1200.	5.475	35.065	5.369	5.34	27.691	27.693	1.50	1492.5	1.7422
1300.	5.072	35.048	4.960	2.89	27.726	27.728	1.06	1492.5	1.7969
1400.	4.719	35.029	4.601	2.17	27.752	27.753	1.02	1492.7	1.8489
1500.	4.493	35.012	4.367	1.81	27.764	27.766	.79	1493.4	1.8996
1600.	4.371	35.012	4.237	-2.24	27.777	27.780	.72	1494.6	1.9494
1800.	4.117	35.005	3.967	1.28	27.799	27.803	.70	1496.9	2.0474
2000.	3.894	34.996	3.728	1.25	27.815	27.820	.69	1499.3	2.1431
2200.	3.733	34.994	3.550	.48	27.830	27.837	.62	1502.0	2.2382
2400.	3.515	34.981	3.315	1.89	27.842	27.850	.69	1504.4	2.3319
2500.	3.411	34.976	3.203	1.18	27.848	27.856	.59	1505.7	2.3782
2600.	3.325	34.970	3.109	.12	27.852	27.860	.57	1507.0	2.4243
2800.	3.140	34.958	2.907	.90	27.860	27.870	.64	1509.6	2.5158
3000.	2.977	34.948	2.727	1.67	27.867	27.878	.59	1512.3	2.6065
3200.	2.823	34.938	2.555	.75	27.874	27.885	.64	1515.0	2.6962
3400.	2.674	34.929	2.388	.15	27.880	27.893	.53	1517.8	2.7845
3600.	2.555	34.922	2.250	.32	27.885	27.898	.52	1520.7	2.8720
3800.	2.467	34.915	2.142	.04	27.893	27.902	.43	1523.8	2.9593
4000.	2.413	34.910	2.067	.11	27.887	27.903	.42	1527.0	3.0471
4200.	2.367	34.908	1.999	.95	27.889	27.907	.35	1530.2	3.1357
4400.	2.349	34.903	1.958	.12	27.887	27.907	.25	1533.6	3.2254
4600.	2.331	34.899	1.917	.24	27.885	27.907	.27	1537.0	3.3168
4800.	2.318	34.894	1.879	.33	27.882	27.906	.27	1540.4	3.4102
5000.	2.314	34.891	1.851	.13	27.880	27.906	.22	1543.8	3.5054
5200.	2.306	34.887	1.817	.38	27.877	27.905	.23	1547.3	3.6027

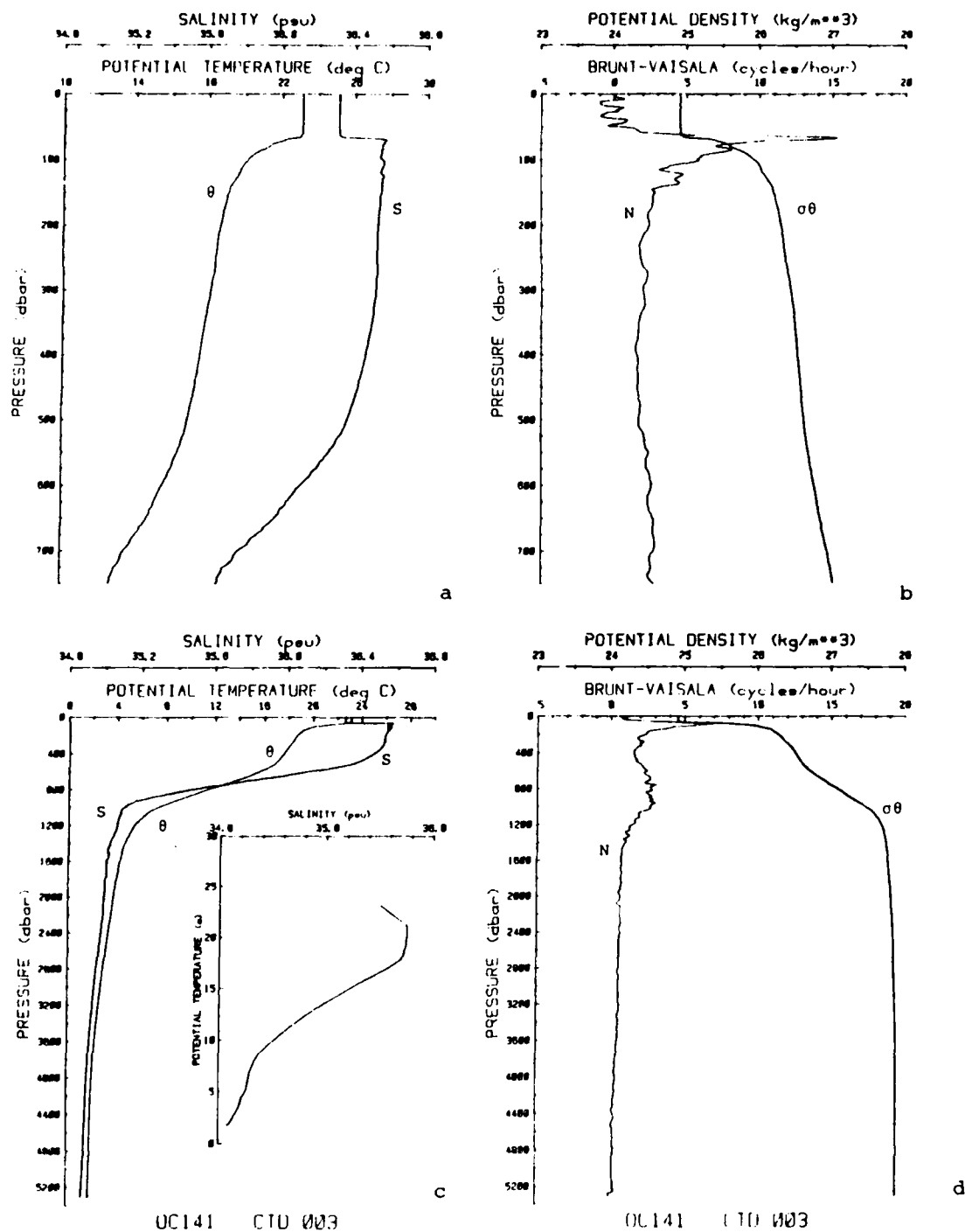


Figure 7. CTD station 3. Profiles of potential temperature ( $\theta$ ) and salinity (S), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) for the upper 750 m (a and b respectively) and for the entire cast (c and d respectively).

$\theta$ -S diagram included in c.

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## B. XBT Data

Expendable bathythermograph data were collected approximately hourly (approximately every 20 km) along 70°W between 39°N and 34°N during the trip to the LOTUS area.

A Bathysystems digital logger stores the XBT casts at 1/10 second intervals (approximately every 60 cm) for later analysis. Using a Sea Data 12A reader with an ARI (asynchronous interface) to an HP85A, we transcribe, edit, annotate, smooth, and store the data in 2 dbar intervals on flexible discs.

The depths of the whole degree isotherms were transcribed from the strip chart records and plotted. Figure 8 is a chart showing the location of individual XBTs taken during the trip south. Figure 9 shows the XBT section from the southbound trip. Also, the locations of XBT's taken on the northbound trip from Bermuda to Woods Hole (Leg 2) are shown in Figure 10. Figure 11 shows the XBT section from this leg. Vertical exaggeration of the XBT sections is 1:463. Figure 12 is an overplot of all the XBTs made in the LOTUS area during OCEANUS cruise 141 (numbers 1-83). This presentation shows the range of temperatures observed due to the combined effects of the temporal and spatial variations.

All LOTUS XBT traces are supplied to the National Oceanographic Data Center for general access and usage.

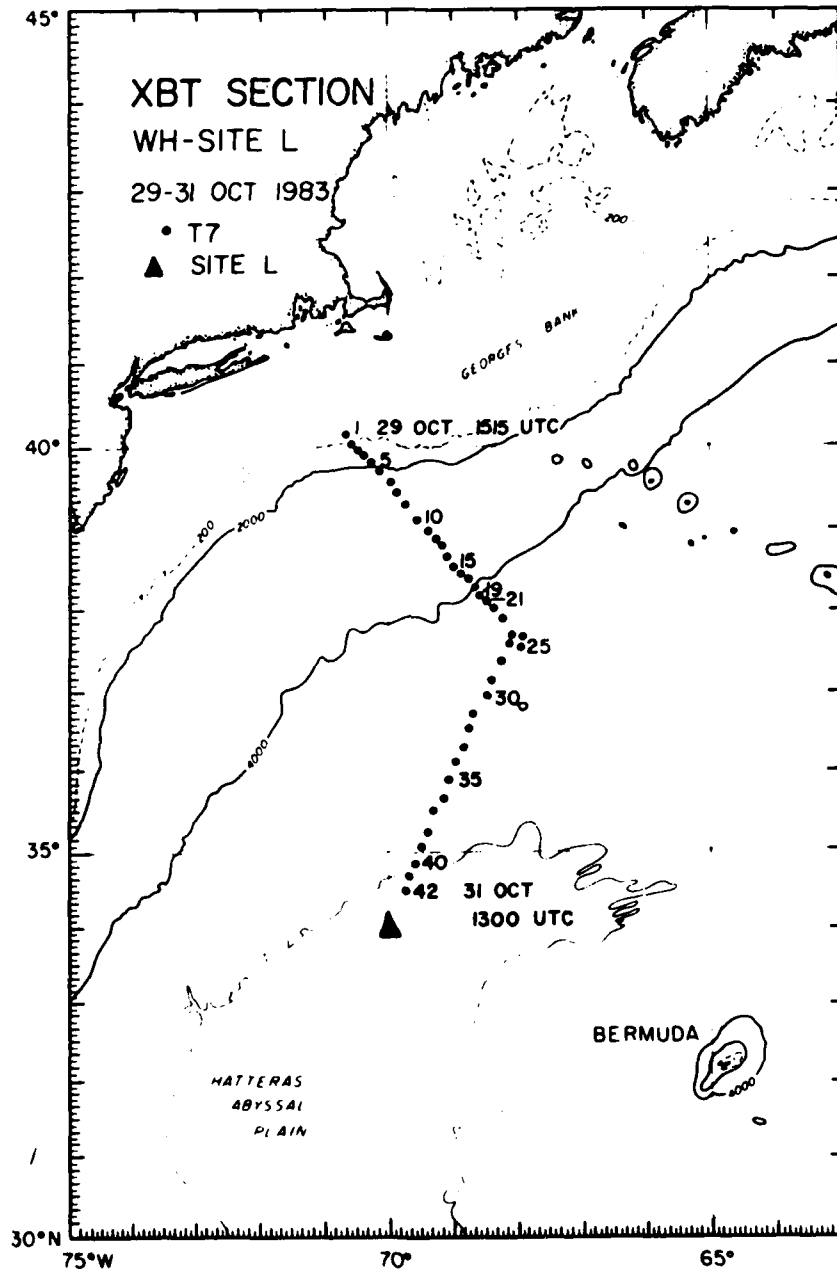


Figure 8. Chart showing the location of individual XBTs taken during the trip south to the LOTUS area.

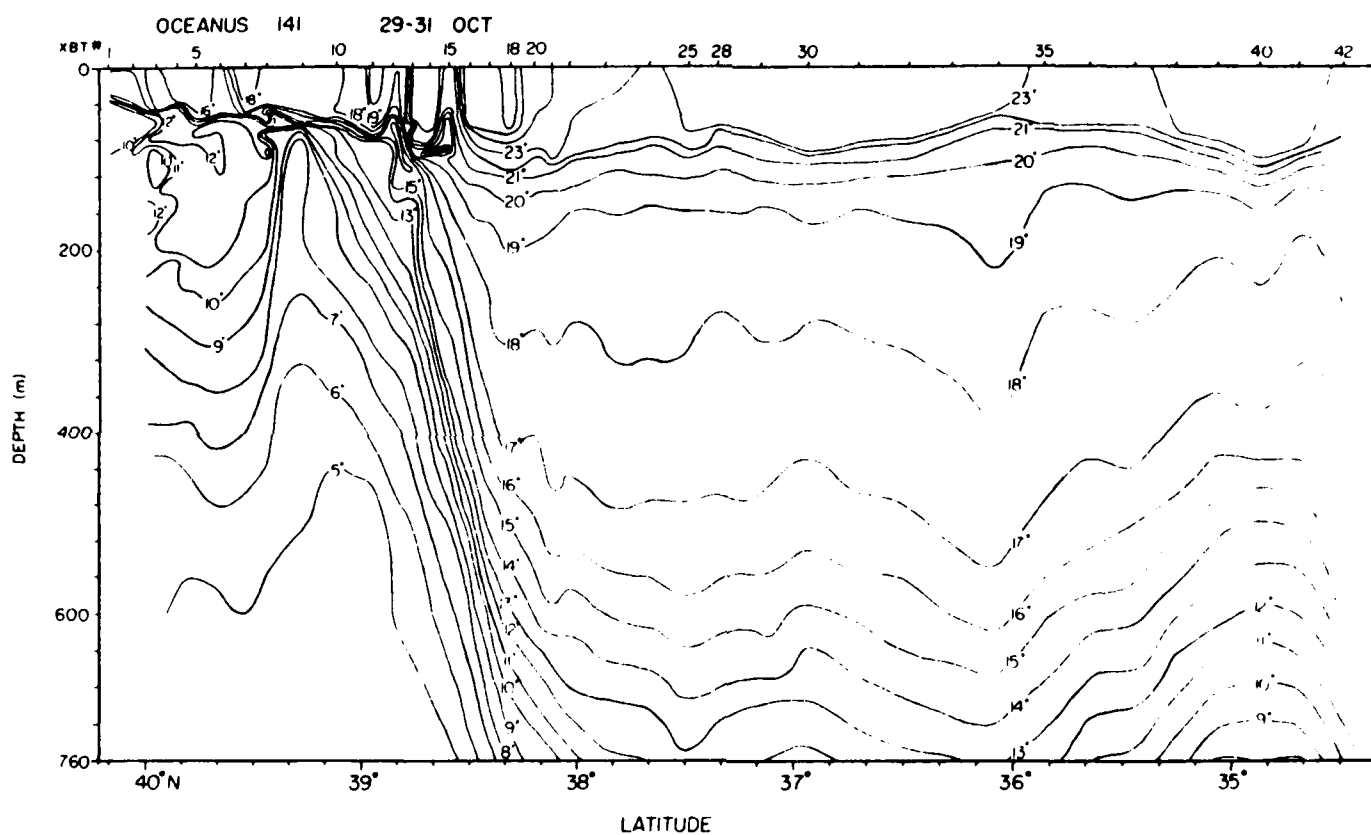


Figure 9. XBT section from the southbound trip along 70°W between 40°N and 34°N.

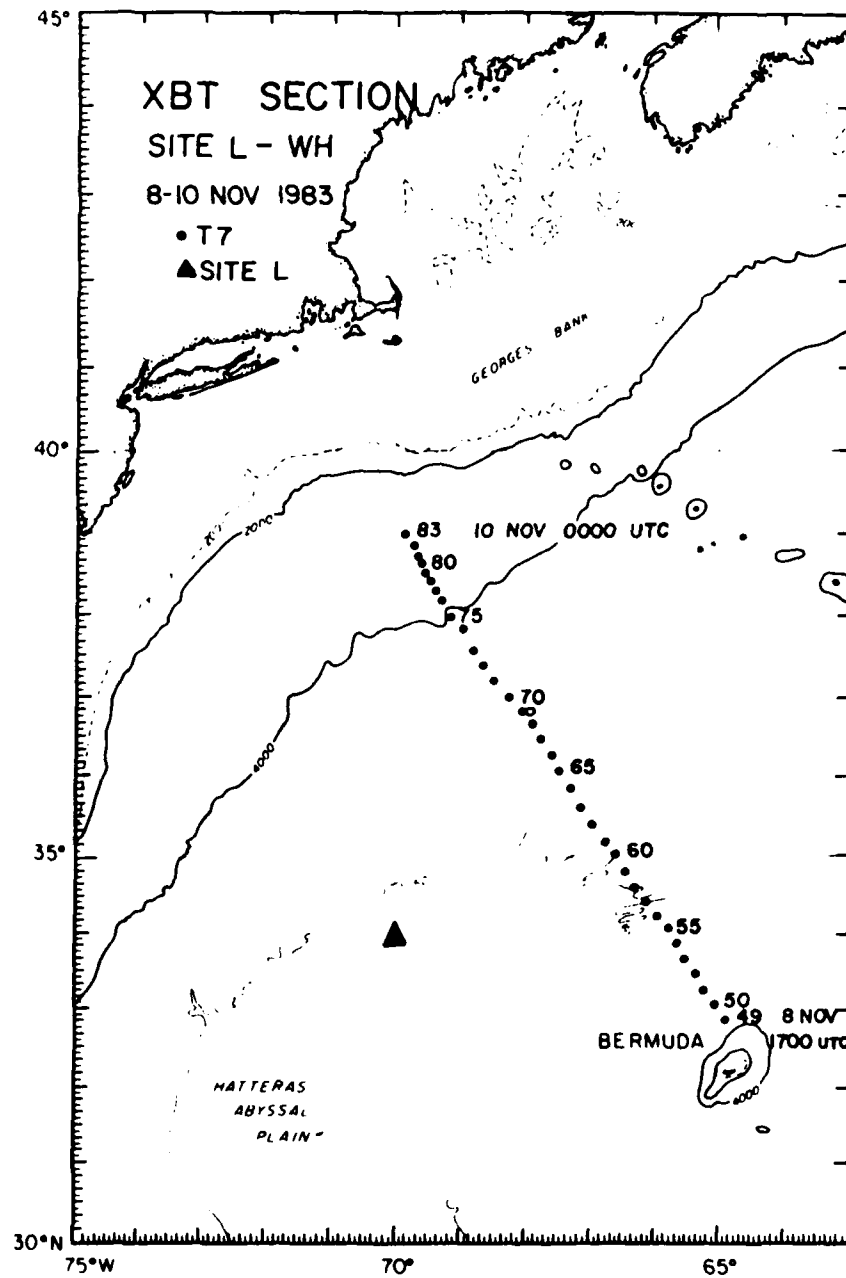


Figure 10. Chart showing the location of individual XBTs taken during Leg 2 of OCEANUS 141 the trip north from Bermuda.

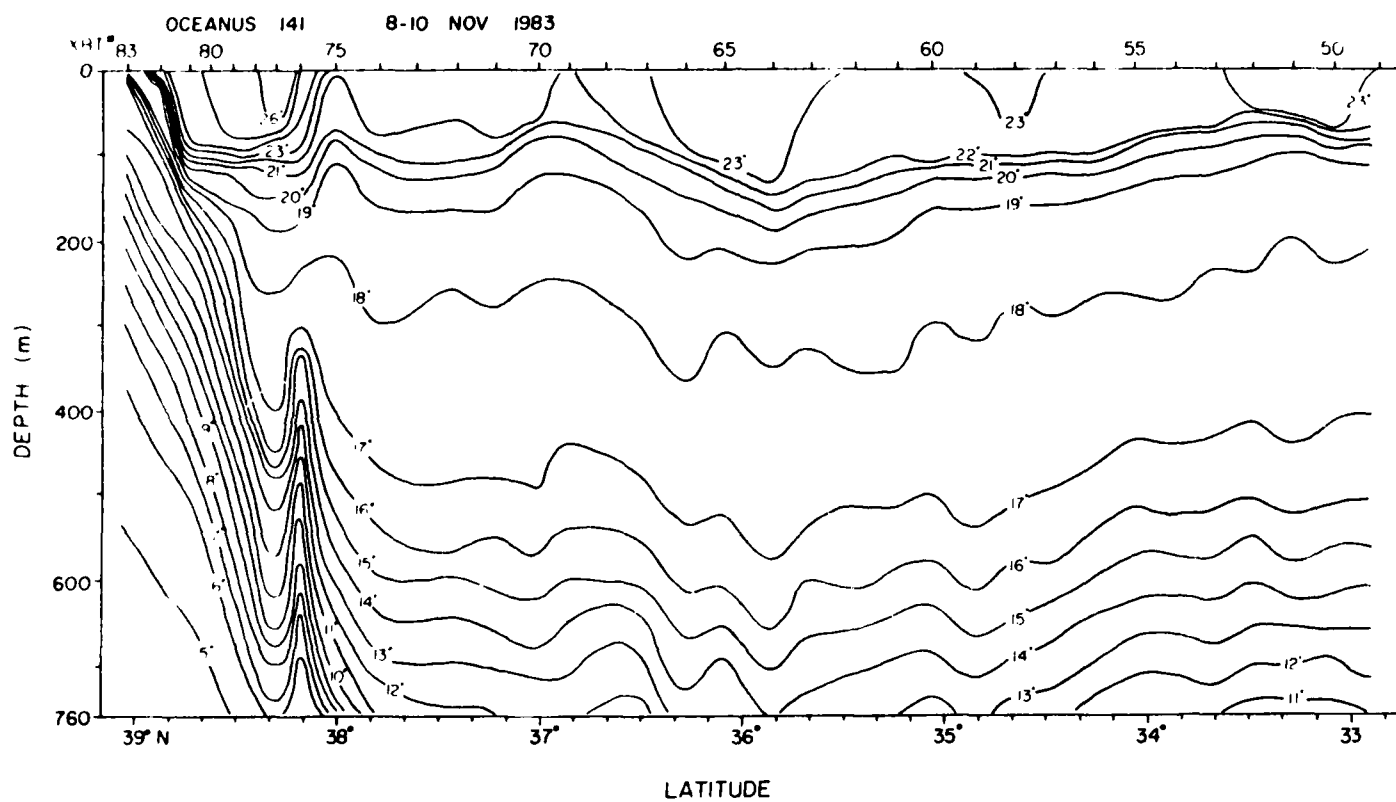


Figure 11. XBT section from the northbound trip from Bermuda to approximately 34°N, 70°W.

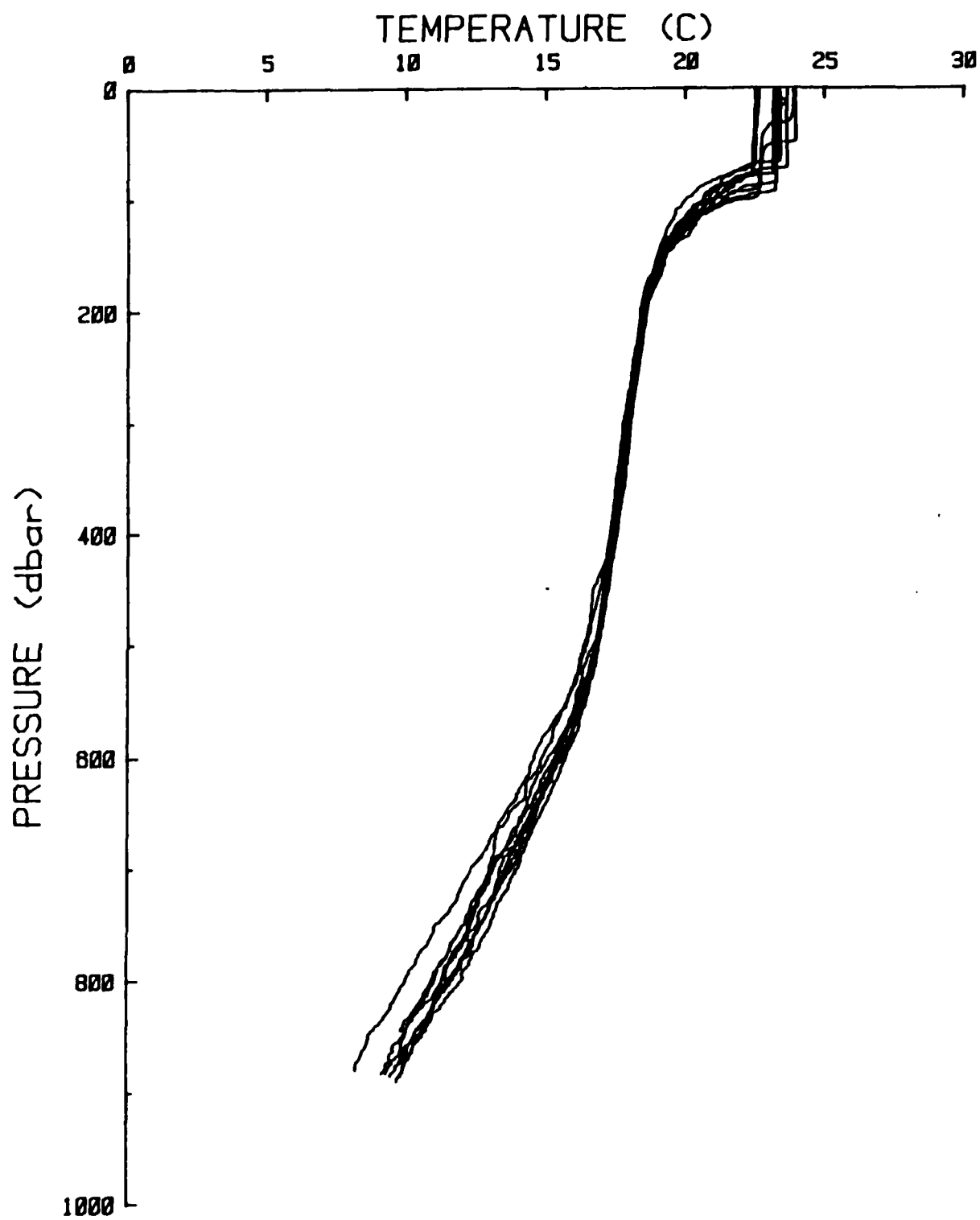


Figure 12. An overplot of XBTs taken in the LOTUS area during OCEANUS 141.

PART III  
Hydrographic Data  
OCEANUS 145  
22-29 January 1984

## A. CTD Data: OC 145

Nine CTD stations were made in the LOTUS area (Figure 13) during OCEANUS 145. The CTD measurements were made by a Neil Brown Instrument Systems internal recording conductivity-temperature-depth profiler (CTD/IR); mechanical and operational details of the LOTUS CTD/IR are found in Trask (1981).

Station 1 was made near the newly deployed LOTUS-6 surface mooring (792). The CTD cast was terminated at approximately 4000 m, because the ship was drifting towards the mooring. Stations 2, 3, and 4 were shallow casts done near the profiling current meter (PCM) during the time period at which it records, thus providing a check on the calibration of the PCM. Stations 5 and 6 were done near the east (789) and south (790) subsurface moorings, respectively. Station 7 was of a series of shallow yo-yos (several down-up profiles) between the surface and 400 m, near the PCM and LOTUS-6. Stations 8 and 9 were completed east and north, respectively, of the LOTUS surface mooring, approximately equidistant with the subsurface moorings from the surface mooring. A summary of the CTD/IR stations taken during OC 145 appears in Table 8.

Table 8: A summary of the CTD/IR work conducted on OCEANUS cruise 145.

CTD Station	Date (year day)	Start Time (UTC)	Deployed Position		Pressure Range (dbar)
			Lat. (N)	Long. (W)	
1	25 Jan 84 (025)	0125	34°01.47'	69°59.13'	0-4056
2	25 Jan 84	0538	34°01.98'	70°03.55'	0-200
3	25 Jan 84	0733	33°56.96'	70°03.95'	0-250
4	25 Jan 84	0832	33°59.78'	69°59.37'	0-210
5	26 Jan 84 (026)	0530	33°59.34'	69°41.68'	0-4876
6	26 Jan 84	1016	33°46.19	69°55.15	0-5350
7	26 Jan 84	2134	34°02.13	69°59.59	0-400
8	27 Jan 84 (027)	0650	33°59.99'	70°12.71	0-5349
9	27 Jan 84	1138	34°11.08	69°59.02	0-5363



# CTD STATIONS LOTUS AREA JANUARY 1984

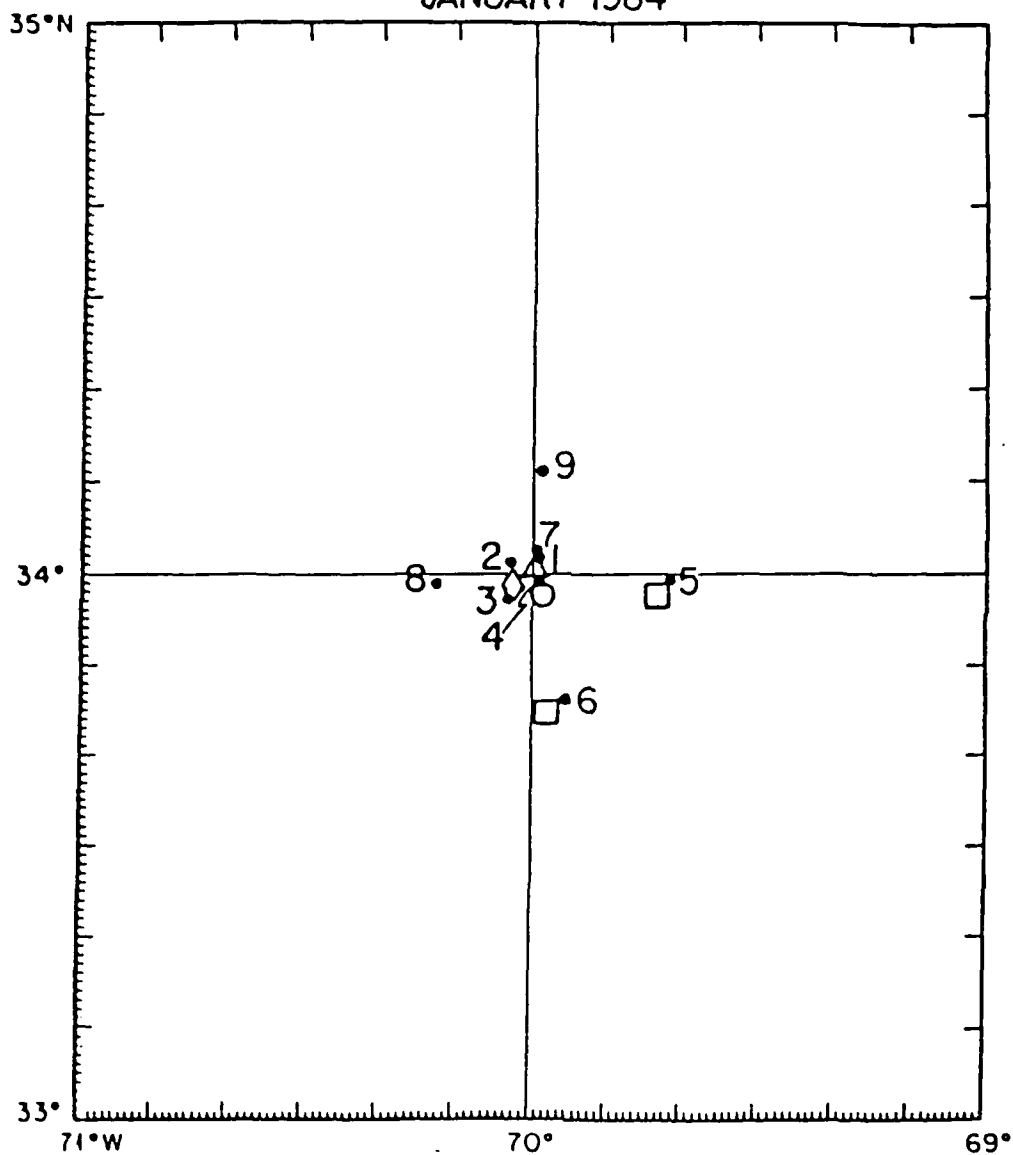


Figure 13. Chart of the LOTUS area showing the locations of the CTD/IR stations (●) made during OCEANUS 145 and their proximity to the LOTUS-6 surface mooring (Δ), near-surface mooring (○), subsurface moorings (□), and PCM (◇).

Table 9: Listing of CTD data and derived quantities for station 1.

OC145	CTD 001	1984 025 0125Z	34 01.56N	69 59.08W	corrD: 5355m				
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
3.	19.167	36.370	19.166	0.00	26.042	26.027	0.00	1520.7	0.0000
6.	19.161	36.396	19.160	2.14	26.063	26.048	3.25	1520.8	.0065
10.	19.161	36.405	19.159	.19	26.070	26.055	2.00	1520.9	.0144
16.	19.160	36.409	19.157	.68	26.074	26.059	1.09	1521.0	.0260
20.	19.169	36.413	19.166	-2.18	26.075	26.060	.88	1521.1	.0339
26.	19.168	36.415	19.163	-.72	26.076	26.062	1.09	1521.2	.0456
30.	19.165	36.415	19.160	.49	26.077	26.063	.38	1521.2	.0537
36.	19.166	36.414	19.160	.09	26.076	26.063	-.21	1521.3	.0653
50.	19.173	36.418	19.164	-2.21	26.077	26.064	.34	1521.6	.0925
66.	19.213	36.435	19.201	-6.53	26.080	26.068	1.38	1522.0	.1237
76.	19.267	36.464	19.253	.11	26.088	26.076	.79	1522.3	.1433
100.	19.235	36.456	19.217	.59	26.090	26.079	.59	1522.6	.1898
126.	19.200	36.457	19.177	2.72	26.101	26.091	2.17	1523.0	.2411
150.	18.970	36.539	18.943	.88	26.222	26.214	4.00	1522.8	.2873
200.	18.412	36.513	18.377	11.22	26.344	26.338	2.57	1522.0	.3775
250.	18.075	36.504	18.031	1.10	26.422	26.418	2.05	1521.9	.4630
300.	17.826	36.487	17.774	7.02	26.471	26.469	1.65	1521.9	.5470
350.	17.546	36.450	17.486	3.66	26.512	26.511	1.65	1521.9	.6295
400.	17.243	36.406	17.176	5.59	26.551	26.553	1.54	1521.8	.7117
450.	16.883	36.346	16.808	9.72	26.592	26.595	1.86	1521.5	.7918
500.	16.297	36.239	16.216	18.90	26.649	26.652	2.24	1520.4	.8700
550.	15.404	36.080	15.317	35.78	26.731	26.735	2.61	1518.3	.9460
600.	14.341	35.897	14.251	8.78	26.825	26.828	2.96	1515.6	1.0185
650.	13.074	35.703	12.982	27.88	26.940	26.942	2.74	1512.0	1.0861
700.	11.992	35.552	11.898	32.77	27.037	27.038	2.68	1509.0	1.1490
750.	10.764	35.400	10.670	13.00	27.148	27.147	2.70	1505.4	1.2068
800.	9.820	35.301	9.725	14.18	27.237	27.235	2.24	1502.7	1.2592
900.	8.049	35.154	7.953	9.77	27.408	27.403	2.67	1497.7	1.3517
1000.	6.570	35.094	6.474	25.30	27.572	27.565	2.48	1493.6	1.4268
1100.	5.948	35.098	5.846	-.32	27.657	27.650	1.25	1492.8	1.4900
1200.	5.269	35.046	5.164	13.09	27.701	27.693	1.16	1491.7	1.5470
1300.	4.921	35.028	4.810	-2.08	27.728	27.719	.90	1491.9	1.6007
1400.	4.691	35.021	4.572	1.49	27.748	27.741	1.03	1492.6	1.6527
1500.	4.454	35.006	4.328	.39	27.763	27.756	.77	1493.3	1.7036
1600.	4.276	34.995	4.143	2.45	27.774	27.767	.74	1494.2	1.7532
1800.	4.054	34.986	3.905	.77	27.791	27.785	.72	1496.6	1.8517
2000.	3.910	34.992	3.744	.19	27.811	27.806	.69	1499.4	1.9487
2200.	3.730	34.987	3.547	1.03	27.825	27.822	.67	1502.0	2.0446
2400.	3.510	34.975	3.310	4.37	27.838	27.836	.53	1504.4	2.1391
2500.	3.428	34.971	3.220	1.09	27.843	27.841	.63	1505.8	2.1862
2600.	3.319	34.965	3.103	1.20	27.849	27.848	.65	1507.0	2.2326
2800.	3.147	34.953	2.914	.26	27.856	27.856	.64	1509.6	2.3248
3000.	2.972	34.943	2.722	.66	27.864	27.865	.58	1512.3	2.4160
3200.	2.807	34.934	2.540	.70	27.872	27.874	.64	1515.0	2.5060
3400.	2.652	34.924	2.366	.94	27.877	27.880	.68	1517.7	2.5947
3600.	2.523	34.916	2.219	.03	27.882	27.886	.52	1520.6	2.6822
3800.	2.429	34.909	2.106	.20	27.884	27.890	.40	1523.6	2.7692
4000.	2.377	34.904	2.032	.21	27.885	27.892	.40	1526.8	2.8566

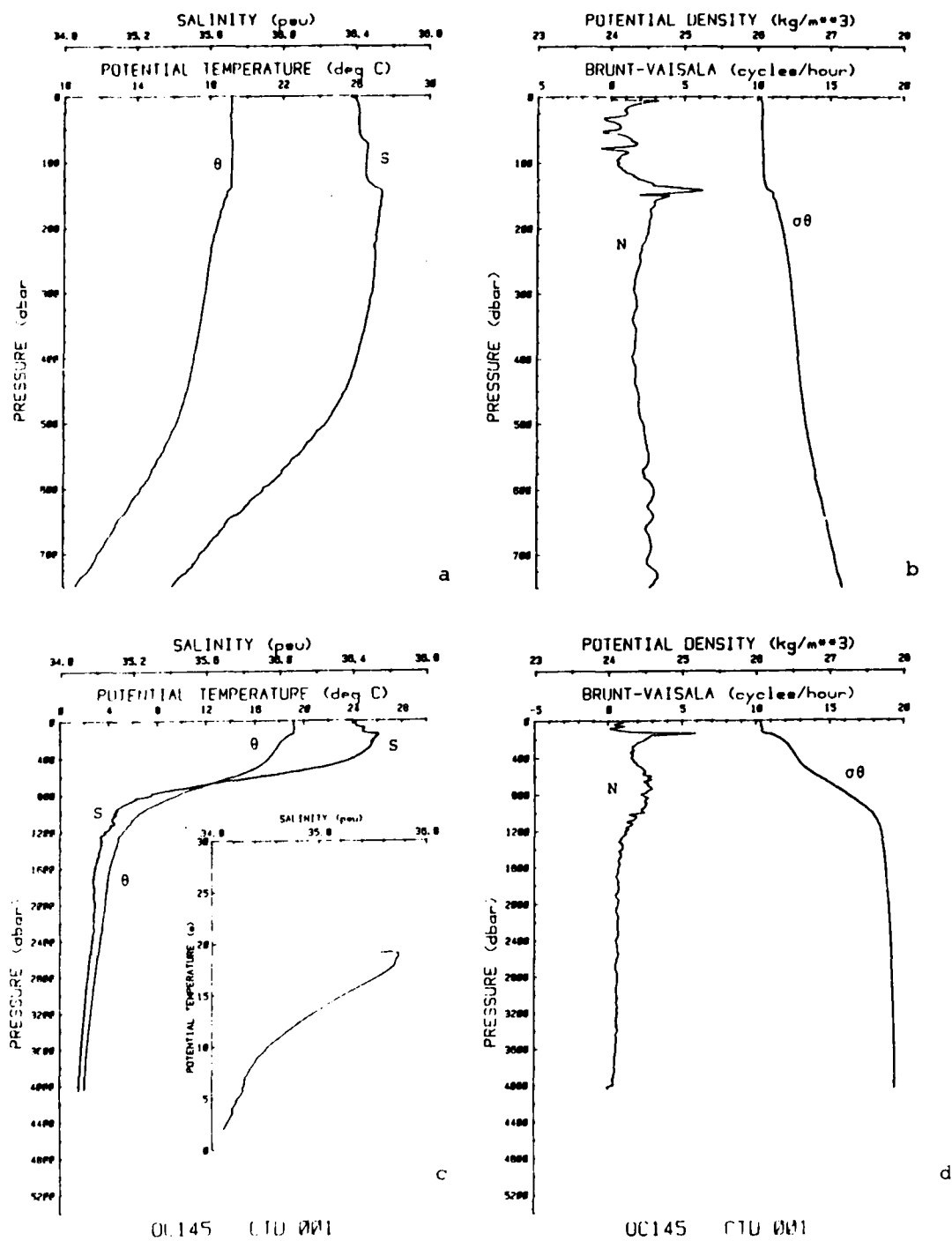


Figure 14. CTD station 1. Profiles of potential temperature ( $\theta$ ) and salinity (S), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) for the upper 750 m (a and b respectively) and for the entire cast (c and d respectively).  $\theta$ -S diagram included in c.

Table 10: Listing of CTD data and derived quantities for stations 2, 3 and 4.

OC145	CTD 002	1984 025 0538Z	34 00.93N	70 03.55W	corrD: 5363m				
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	19.075	36.388	19.076	0.00	26.080	26.073	0.00	1520.5	0.0000
6.	19.077	36.389	19.077	-.14	26.080	26.074	.45	1520.5	.0080
10.	19.079	36.390	19.077	-.18	26.080	26.074	-.28	1520.6	.0161
16.	19.078	36.389	19.075	1.05	26.079	26.073	.26	1520.7	.0278
20.	19.081	36.390	19.077	-1.50	26.080	26.074	.08	1520.8	.0351
26.	19.084	36.390	19.080	.26	26.079	26.073	-.25	1520.9	.0467
30.	19.093	36.392	19.088	-1.87	26.078	26.073	.30	1521.0	.0543
36.	19.099	36.395	19.093	-4.96	26.079	26.073	-.37	1521.1	.0662
50.	19.094	36.391	19.085	-1.15	26.077	26.073	.57	1521.3	.0736
66.	19.163	36.418	19.152	-1.00	26.080	26.077	1.11	1521.8	.1252
76.	19.168	36.421	19.155	-.12	26.081	26.078	.65	1522.0	.1445
100.	19.171	36.422	19.153	.04	26.081	26.079	.46	1522.4	.1919
126.	19.174	36.421	19.152	.31	26.080	26.079	.14	1522.8	.2428
150.	19.168	36.434	19.141	1.33	26.091	26.091	4.30	1523.2	.2907

OC145	CTD 003	1984 025 0733Z	33 56.96N	70 03.95W	corrD: 5363m				
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	19.177	36.419	19.177	0.00	26.077	26.070	0.00	1520.8	0.0000
6.	19.174	36.421	19.173	1.35	26.080	26.073	1.16	1520.9	.0075
10.	19.176	36.422	19.174	-.41	26.080	26.074	.51	1520.9	.0154
16.	19.176	36.423	19.173	.29	26.080	26.074	.36	1521.0	.0272
20.	19.176	36.423	19.173	.40	26.080	26.074	.18	1521.1	.0345
26.	19.178	36.423	19.173	.15	26.080	26.075	.47	1521.2	.0463
30.	19.178	36.423	19.173	.13	26.080	26.075	-.17	1521.3	.0541
36.	19.181	36.424	19.175	-.37	26.080	26.075	.49	1521.4	.0661
50.	19.188	36.426	19.179	.15	26.080	26.075	-.10	1521.6	.0935
66.	19.192	36.426	19.180	-.37	26.079	26.075	-.28	1521.9	.1246
76.	19.191	36.426	19.178	.83	26.079	26.076	.38	1522.1	.1441
100.	19.201	36.427	19.184	-.55	26.077	26.075	-.10	1522.5	.1910
126.	19.205	36.438	19.173	.11	26.084	26.083	1.80	1523.0	.2428
150.	19.178	36.487	19.151	11.86	26.128	26.129	4.41	1523.3	.2902
200.	18.289	36.473	18.254	3.35	26.345	26.347	2.55	1521.6	.3806

OC145	CTD 004	1984 025 0832Z	33 59.79N	69 59.32W	corrD: 5300m				
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	19.165	36.429	19.165	0.00	26.088	26.082	0.00	1520.8	0.0000
6.	19.165	36.429	19.164	.43	26.088	26.081	-.20	1520.8	.0087
10.	19.166	36.429	19.164	-.25	26.088	26.081	.56	1520.9	.0162
16.	19.167	36.430	19.164	-.32	26.088	26.082	.72	1521.0	.0278
20.	19.167	36.432	19.162	.51	26.089	26.084	1.07	1521.1	.0358
26.	19.168	36.430	19.164	-.78	26.088	26.083	-.92	1521.2	.0472
30.	19.169	36.430	19.164	-.04	26.088	26.083	.72	1521.3	.0552
36.	19.168	36.432	19.162	.16	26.089	26.084	.13	1521.3	.0665
50.	19.171	36.432	19.162	-.25	26.088	26.084	.19	1521.6	.0941
66.	19.174	36.434	19.162	.18	26.090	26.086	.36	1521.9	.1247
76.	19.175	36.435	19.162	-.38	26.090	26.086	.11	1522.0	.1447
100.	19.182	36.436	19.164	-.43	26.089	26.087	.63	1522.5	.1916
126.	19.186	36.437	19.163	-.10	26.089	26.088	.79	1522.9	.2429
150.	19.190	36.441	19.163	.77	26.090	26.091	2.74	1523.3	.2899
200.	18.395	36.490	18.360	10.60	26.331	26.333	0.00	1521.9	.3820

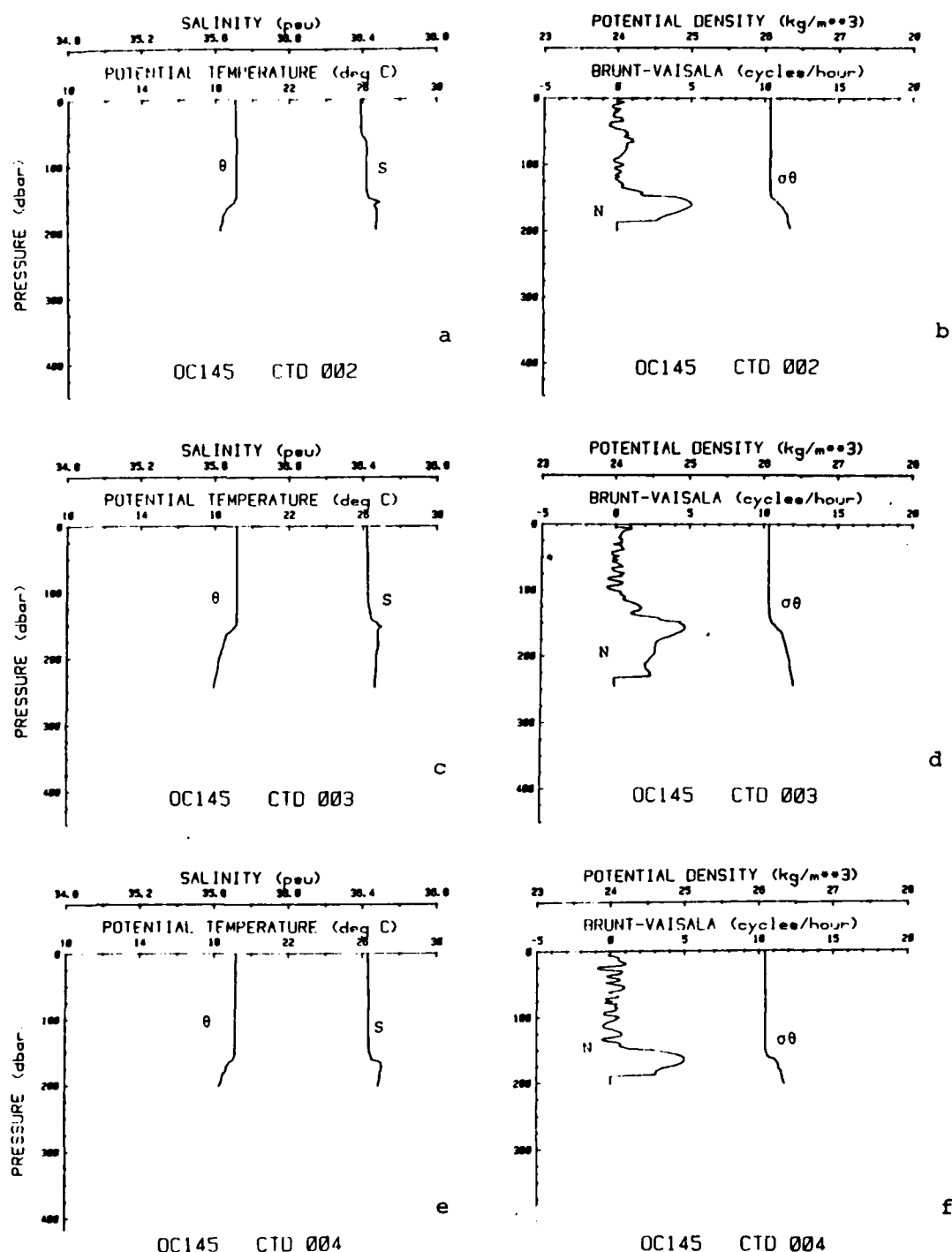


Figure 15. CTD stations 2, 3 and 4. Profiles of potential temperature ( $\theta$ ) and salinity (S) (a, c, e), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) (b, d, f) for approximately the upper 200 m at each station.

Table 11: Listing of CTD data and derived quantities for station 5.

DC145	CTD 005	1984 026 0530Z	33 59.34N 69 41.68W	corrD: 5355m					
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	19.759	36.414	19.759	0.00	25.921	25.915	0.00	1522.4	0.0000
6.	19.765	36.412	19.765	-1.00	25.918	25.912	-.76	1522.5	.0082
10.	19.766	36.414	19.765	.21	25.919	25.913	.49	1522.6	.0167
16.	19.775	36.419	19.773	-2.13	25.921	25.914	1.50	1522.7	.0287
20.	19.777	36.424	19.773	.22	25.924	25.918	2.14	1522.8	.0376
26.	19.753	36.428	19.748	3.69	25.934	25.928	1.97	1522.8	.0495
30.	19.744	36.430	19.739	2.07	25.937	25.932	1.34	1522.9	.0588
36.	19.742	36.430	19.736	-.08	25.938	25.933	.69	1522.9	.0707
50.	19.743	36.430	19.734	.15	25.938	25.934	.40	1523.2	.1000
66.	19.742	36.429	19.730	.44	25.937	25.934	.51	1523.4	.1338
76.	19.730	36.426	19.716	1.65	25.938	25.935	.84	1523.6	.1544
100.	19.671	36.431	19.653	11.35	25.958	25.956	3.14	1523.8	.2052
126.	19.338	36.510	19.316	20.40	26.104	26.104	4.19	1523.4	.2579
150.	19.008	36.511	18.982	15.41	26.191	26.191	3.77	1522.9	.3040
200.	18.440	36.503	18.405	8.77	26.330	26.332	2.39	1522.1	.3947
250.	18.087	36.486	18.043	6.26	26.405	26.410	1.77	1521.9	.4815
300.	17.931	36.482	17.879	4.21	26.441	26.448	1.51	1522.2	.5668
350.	17.761	36.467	17.701	12.15	26.471	26.480	1.46	1522.6	.6513
400.	17.451	36.428	17.383	3.09	26.518	26.528	1.84	1522.4	.7346
450.	17.143	36.383	17.068	3.71	26.558	26.570	1.55	1522.3	.8163
500.	16.735	36.316	16.652	15.83	26.604	26.618	1.89	1521.8	.8974
550.	16.030	36.183	15.941	34.47	26.667	26.681	2.53	1520.4	.9760
600.	15.030	36.009	14.937	5.88	26.760	26.774	2.35	1517.9	1.0515
650.	14.081	35.858	13.985	38.09	26.850	26.863	2.82	1515.5	1.1234
700.	12.964	35.684	12.866	8.25	26.948	26.960	2.68	1512.5	1.1905
750.	11.705	35.498	11.606	22.53	27.050	27.060	2.78	1508.8	1.2534
800.	10.397	35.332	10.299	45.24	27.161	27.169	2.99	1504.8	1.3107
900.	8.589	35.180	8.490	16.90	27.344	27.350	2.55	1499.7	1.4117
1000.	7.108	35.098	7.008	8.65	27.501	27.504	2.42	1495.7	1.4945
1100.	6.142	35.090	6.039	-1.34	27.626	27.628	1.78	1493.6	1.5627
1200.	5.539	35.066	5.432	-1.95	27.684	27.685	1.50	1492.8	1.6227
1300.	5.228	35.065	5.113	-2.11	27.721	27.723	1.32	1493.2	1.6786
1400.	4.745	35.030	4.626	.63	27.750	27.751	.87	1492.8	1.7310
1500.	4.629	35.034	4.501	4.34	27.766	27.768	.81	1494.0	1.7817
1600.	4.387	35.014	4.253	1.41	27.778	27.780	.87	1494.7	1.8318
1800.	4.083	34.992	3.934	1.19	27.793	27.796	.70	1496.7	1.9303
2000.	3.950	35.001	3.783	1.64	27.813	27.819	.70	1499.5	2.0272
2200.	3.749	34.995	3.566	1.91	27.829	27.836	.61	1502.1	2.1229
2400.	3.530	34.983	3.330	1.27	27.842	27.850	.66	1504.5	2.2171
2500.	3.454	34.979	3.246	.46	27.847	27.855	.55	1505.9	2.2637
2600.	3.361	34.972	3.144	1.31	27.850	27.859	.61	1507.2	2.3102
2800.	3.164	34.957	2.931	1.27	27.857	27.867	.60	1509.7	2.4025
3000.	2.982	34.943	2.731	.73	27.863	27.874	.60	1512.3	2.4939
3200.	2.820	34.934	2.552	.58	27.870	27.882	.67	1515.0	2.5842
3400.	2.660	34.924	2.375	.66	27.877	27.890	.56	1517.7	2.6729
3600.	2.547	34.918	2.243	.69	27.882	27.895	.56	1520.7	2.7613
3800.	2.445	34.910	2.121	.98	27.884	27.899	.46	1523.7	2.8488
4000.	2.381	34.905	2.036	.11	27.885	27.902	.40	1526.8	2.9366
4200.	2.340	34.899	1.973	.53	27.885	27.903	.25	1530.1	3.0252
4400.	2.321	34.896	1.931	.12	27.884	27.903	.30	1533.5	3.1151
4600.	2.307	34.893	1.894	.09	27.883	27.904	.16	1536.9	3.2065
4800.	2.299	34.888	1.862	.32	27.879	27.902	.27	1540.3	3.3001

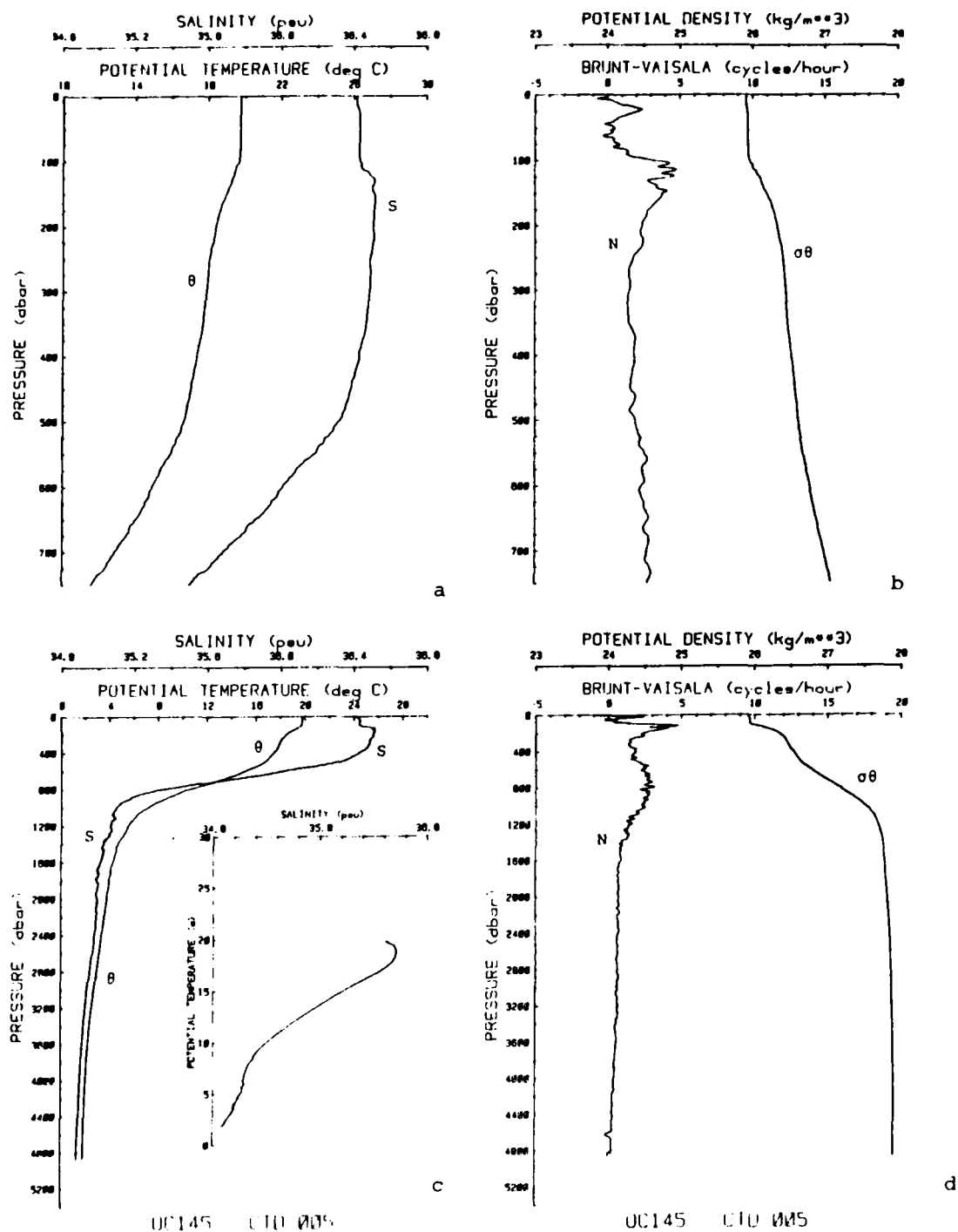


Figure 16. CTD station 5. Profiles of potential temperature ( $\theta$ ) and salinity (S), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) for the upper 750 m (a and b respectively) and for the entire cast (c and d respectively).  $\theta$ -S diagram included in c.

Table 12: Listing of CTD data and derived quantities for station 6.

UC145	CTD 006	1984 026 1016Z			33 46.19N 69 55.15W		corrD: 5383m		
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
0.	0.000	0.000	-0.000	0.00	-0.93	-1.47	0.00	1402.4	0.0000
6.	19.403	36.431	19.402	-6.13	26.028	26.021	90.38	1521.5	.0659
10.	19.407	36.431	19.406	-2.35	26.027	26.020	-.27	1521.6	.0741
16.	19.399	36.430	19.396	2.85	26.028	26.022	-.30	1521.7	.0858
20.	19.404	36.431	19.401	.42	26.027	26.021	-.70	1521.7	.0939
26.	19.405	36.430	19.401	-.21	26.026	26.021	.33	1521.8	.1054
30.	19.405	36.430	19.400	.30	26.027	26.021	.27	1521.9	.1143
36.	19.405	36.430	19.399	.37	26.026	26.021	-.39	1522.0	.1257
50.	19.404	36.430	19.395	.20	26.027	26.022	-.43	1522.2	.1542
66.	19.414	36.431	19.402	.83	26.025	26.021	-.36	1522.5	.1860
76.	19.415	36.431	19.402	-.03	26.025	26.022	1.05	1522.7	.2060
100.	19.357	36.456	19.340	.70	26.059	26.057	1.40	1523.0	.2540
126.	19.276	36.459	19.253	5.94	26.082	26.081	2.32	1523.2	.3063
150.	19.021	36.515	18.995	24.08	26.190	26.191	4.57	1522.9	.3528
200.	18.416	36.505	18.381	9.56	26.338	26.340	2.34	1522.0	.4432
250.	18.113	36.494	18.069	2.24	26.405	26.409	1.71	1522.0	.5295
300.	17.929	36.484	17.877	3.69	26.443	26.450	1.74	1522.2	.6148
350.	17.676	36.459	17.616	5.76	26.486	26.495	1.56	1522.3	.6986
400.	17.314	36.407	17.247	12.65	26.535	26.545	1.79	1522.0	.7810
450.	16.979	36.356	16.904	11.30	26.577	26.589	1.54	1521.8	.8620
500.	16.629	36.296	16.547	16.62	26.614	26.627	1.70	1521.5	.9421
550.	15.712	36.125	15.625	15.96	26.696	26.709	2.63	1519.3	1.0207
600.	14.847	35.980	14.755	.09	26.778	26.791	2.13	1517.3	1.0946
650.	14.215	35.877	14.118	35.96	26.836	26.849	2.63	1516.0	1.1667
700.	13.168	35.705	13.068	13.26	26.923	26.935	2.27	1513.2	1.2346
750.	12.398	35.600	12.295	13.82	26.996	27.008	2.27	1511.3	1.2995
800.	11.202	35.445	11.099	35.94	27.103	27.113	3.13	1507.8	1.3601
900.	8.631	35.169	8.531	18.17	27.329	27.334	2.83	1499.9	1.4633
1000.	6.967	35.093	6.868	3.00	27.517	27.520	2.01	1495.1	1.5455
1100.	5.955	35.068	5.854	11.09	27.633	27.635	1.82	1492.8	1.6127
1200.	5.350	35.047	5.244	5.34	27.692	27.693	1.39	1492.0	1.6714
1300.	4.931	35.032	4.820	4.71	27.730	27.731	1.07	1491.9	1.7255
1400.	4.655	35.017	4.537	1.16	27.750	27.751	.91	1492.5	1.7775
1500.	4.512	35.015	4.386	-1.19	27.764	27.766	.78	1493.5	1.8279
1600.	4.350	35.007	4.217	2.75	27.776	27.778	.75	1494.5	1.8779
1800.	4.063	34.991	3.914	2.34	27.794	27.798	.70	1496.7	1.9762
2000.	3.907	34.990	3.741	.01	27.810	27.815	.63	1499.4	2.0731
2200.	3.748	34.990	3.565	1.89	27.826	27.832	.68	1502.1	2.1692
2400.	3.532	34.979	3.333	1.15	27.839	27.846	.66	1504.5	2.2640
2500.	3.428	34.969	3.220	1.13	27.841	27.849	.59	1505.7	2.3109
2600.	3.336	34.966	3.120	1.52	27.847	27.856	.63	1507.0	2.3576
2800.	3.166	34.954	2.933	1.14	27.854	27.864	.56	1509.7	2.4504
3000.	2.975	34.941	2.725	.85	27.862	27.872	.57	1512.3	2.5421
3200.	2.806	34.931	2.538	.74	27.870	27.881	.55	1515.0	2.6324
3400.	2.672	34.923	2.387	.08	27.875	27.888	.53	1517.8	2.7215
3600.	2.554	34.915	2.250	.70	27.879	27.893	.50	1520.7	2.8099
3800.	2.465	34.908	2.140	.15	27.881	27.896	.49	1523.7	2.8981
4000.	2.397	34.903	2.051	.45	27.883	27.899	.38	1526.9	2.9864
4200.	2.351	34.899	1.984	.66	27.883	27.901	.33	1530.1	3.0755
4400.	2.328	34.895	1.938	.29	27.882	27.902	.31	1533.5	3.1659
4600.	2.316	34.891	1.902	.22	27.880	27.901	.18	1536.9	3.2579
4800.	2.310	34.888	1.872	.29	27.878	27.901	.21	1540.3	3.3519
5000.	2.299	34.883	1.836	.30	27.875	27.901	.21	1543.8	3.4477
5200.	2.286	34.879	1.799	.14	27.873	27.900	.27	1547.2	3.5452



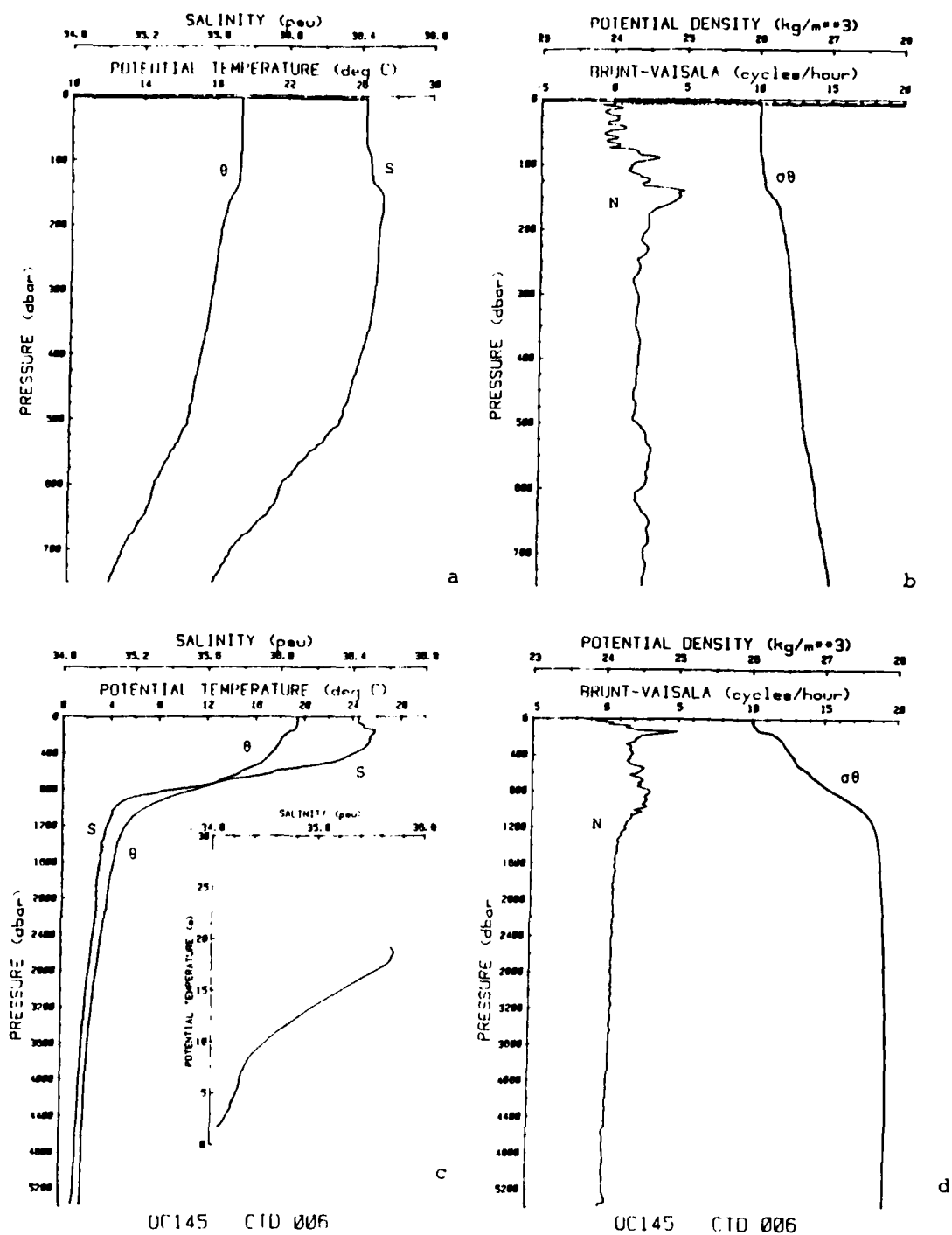


Figure 17. CTD station 6. Profiles of potential temperature ( $\theta$ ) and salinity (S), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) for the upper 750 m (a and b respectively) and for the entire cast (c and d respectively).  $\theta$ -S diagram included in c.

Table 13: Listing of CTD data and derived quantities for station 7.

OC145	CTD 007	1984 026 2134Z	34 02.13N 69 59.59W	corrD: 5363m					
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	19.318	36.464	19.318	0.00	26.075	26.068	0.00	1521.2	0.0000
6.	19.331	36.465	19.331	-1.79	26.072	26.066	-.50	1521.3	.0071
10.	19.323	36.465	19.322	4.12	26.074	26.068	-.51	1521.4	.0149
16.	19.333	36.463	19.330	1.32	26.071	26.065	-1.07	1521.5	.0266
20.	19.331	36.462	19.328	1.30	26.070	26.064	-.66	1521.6	.0349
26.	19.333	36.462	19.329	.54	26.069	26.064	.18	1521.7	.0461
30.	19.337	36.462	19.332	-.79	26.069	26.064	-.78	1521.8	.0542
36.	19.342	36.462	19.336	-.13	26.067	26.062	-.44	1521.9	.0658
50.	19.345	36.462	19.336	.08	26.067	26.062	.50	1522.1	.0933
66.	19.348	36.462	19.336	.19	26.066	26.062	.33	1522.4	.1254
76.	19.351	36.462	19.337	-.42	26.065	26.062	-.50	1522.6	.1444
100.	19.341	36.470	19.323	3.31	26.074	26.072	1.28	1522.9	.1917
126.	19.304	36.497	19.282	4.12	26.103	26.103	2.48	1523.3	.2438
150.	19.096	36.527	19.070	1.40	26.180	26.181	3.87	1523.2	.2899
200.	18.491	36.544	18.456	21.84	26.348	26.351	2.66	1522.3	.3800
250.	18.140	36.533	18.097	7.73	26.428	26.432	2.06	1522.1	.4662
300.	17.914	36.524	17.863	4.81	26.477	26.484	1.56	1522.2	.5491
350.	17.662	36.500	17.602	4.54	26.521	26.530	1.85	1522.3	.6324
400.	17.352	36.451	17.284	5.88	26.559	26.570	0.00	1522.2	.7134

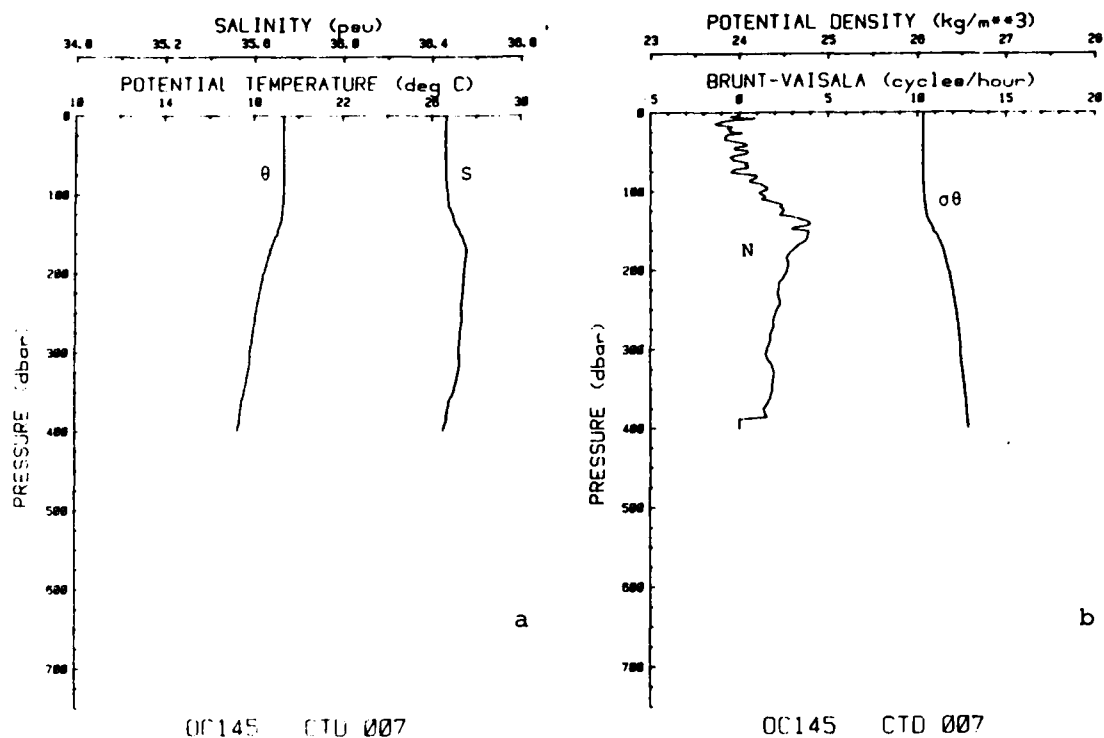


Figure 18. CTD station 7. Profiles of potential temperature ( $\theta$ ) and salinity (S) (a), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) (b) for the upper 400 m.

Table 14: Listing of CTD data and derived quantities for station 8.

OC145	CTD 008	1984 027 0650Z	33 59.99N 70 12.71W	corrD: 5368m					
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	21.061	36.342	21.061	0.00	25.517	25.509	0.00	1525.9	0.0000
6.	21.066	36.333	21.065	4.00	25.509	25.501	4.39	1525.9	.0091
10.	20.873	36.339	20.872	61.02	25.566	25.559	6.02	1525.5	.0193
16.	20.781	36.352	20.778	7.04	25.601	25.594	2.63	1525.4	.0337
20.	20.771	36.353	20.767	4.88	25.605	25.598	7.88	1525.4	.0430
26.	20.038	36.391	20.034	157.20	25.830	25.824	9.68	1523.6	.0569
30.	19.808	36.416	19.803	50.12	25.910	25.905	7.12	1523.0	.0659
36.	19.597	36.423	19.591	12.48	25.971	25.966	3.91	1522.5	.0781
50.	19.478	36.430	19.470	21.55	26.007	26.003	3.66	1522.4	.1067
66.	19.319	36.436	19.308	-.02	26.053	26.050	.68	1522.3	.1383
76.	19.317	36.439	19.304	.32	26.056	26.053	1.05	1522.4	.1585
100.	19.315	36.442	19.297	.84	26.059	26.057	.90	1522.8	.2054
126.	19.265	36.474	19.242	19.15	26.096	26.095	4.75	1523.2	.2582
150.	18.964	36.515	18.937	6.56	26.206	26.206	3.15	1522.8	.3035
200.	18.594	36.522	18.559	2.52	26.305	26.308	2.19	1522.5	.3943
250.	18.228	36.510	18.185	5.80	26.388	26.393	2.08	1522.3	.4825
300.	17.964	36.497	17.912	3.22	26.444	26.451	1.89	1522.4	.5676
350.	17.670	36.465	17.610	8.32	26.492	26.501	1.85	1522.3	.6515
400.	17.354	36.416	17.286	19.46	26.532	26.543	1.76	1522.1	.7340
450.	17.016	36.362	16.940	10.60	26.572	26.584	1.79	1521.9	.8151
500.	16.316	36.233	16.234	20.30	26.639	26.652	2.40	1520.5	.8950
550.	15.441	36.083	15.355	3.87	26.725	26.737	2.52	1518.4	.9718
600.	14.416	35.910	14.326	6.83	26.818	26.831	2.66	1515.8	1.0440
650.	13.263	35.728	13.170	40.87	26.921	26.932	2.87	1512.7	1.1124
700.	12.015	35.543	11.921	23.46	27.026	27.036	2.91	1509.1	1.1759
750.	11.057	35.433	10.961	16.87	27.121	27.130	2.88	1506.5	1.2344
800.	9.878	35.298	9.783	23.25	27.225	27.232	2.77	1503.0	1.2879
900.	7.629	35.116	7.536	12.22	27.440	27.443	2.40	1496.0	1.3788
1000.	6.586	35.109	6.490	2.97	27.582	27.584	1.96	1493.7	1.4510
1100.	5.785	35.084	5.685	7.65	27.667	27.668	1.67	1492.1	1.5132
1200.	5.243	35.066	5.138	.10	27.720	27.721	.49	1491.6	1.5685
1300.	4.982	35.051	4.870	2.13	27.739	27.740	.98	1492.2	1.6209
1400.	4.684	35.029	4.565	1.16	27.756	27.758	.85	1492.6	1.6720
1500.	4.542	35.028	4.415	.23	27.771	27.773	.75	1493.7	1.7217
1600.	4.356	35.014	4.222	3.22	27.781	27.783	.68	1494.6	1.7713
1800.	4.090	34.997	3.941	-.43	27.796	27.799	.71	1496.8	1.8690
2000.	3.883	34.991	3.717	2.38	27.812	27.817	.72	1499.3	1.9655
2200.	3.711	34.988	3.529	1.52	27.828	27.834	.58	1501.9	2.0605
2400.	3.575	34.989	3.375	2.03	27.842	27.850	.60	1504.7	2.1548
2500.	3.434	34.975	3.226	.73	27.845	27.853	.64	1505.8	2.2015
2600.	3.301	34.964	3.085	.75	27.849	27.858	.64	1506.9	2.2478
2800.	3.098	34.952	2.866	2.34	27.859	27.868	.68	1509.4	2.3392
3000.	2.918	34.940	2.669	1.54	27.866	27.876	.53	1512.0	2.4292
3200.	2.774	34.931	2.508	.92	27.873	27.884	.62	1514.8	2.5183
3400.	2.631	34.923	2.346	1.09	27.878	27.891	.59	1517.6	2.6064
3600.	2.517	34.915	2.213	.30	27.882	27.896	.52	1520.5	2.6936
3800.	2.432	34.909	2.108	1.42	27.885	27.900	.43	1523.6	2.7806
4000.	2.380	34.904	2.036	.34	27.885	27.902	.40	1526.8	2.8683
4200.	2.347	34.901	1.980	.25	27.885	27.903	.29	1530.1	2.9567
4400.	2.325	34.898	1.935	.12	27.885	27.904	.28	1533.5	3.0466
4600.	2.317	34.893	1.903	-.08	27.881	27.903	.20	1536.9	3.1384
4800.	2.311	34.889	1.873	-.01	27.879	27.903	.25	1540.4	3.2321
5000.	2.305	34.886	1.842	.17	27.877	27.902	.24	1543.8	3.3277
5200.	2.285	34.880	1.797	.36	27.874	27.901	.31	1547.2	3.4251

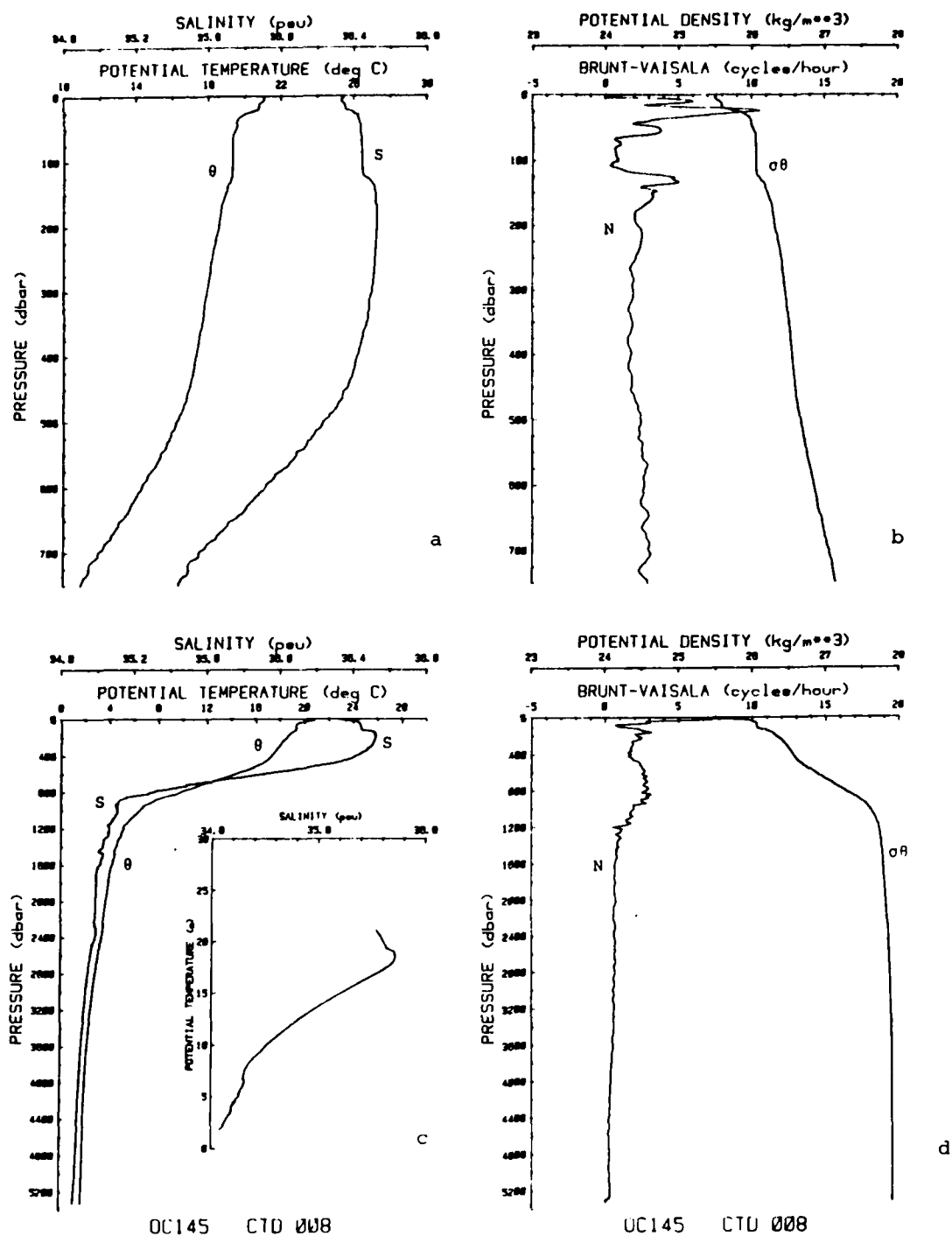


Figure 19. CTD station 8. Profiles of potential temperature ( $\theta$ ) and salinity (S), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) for the upper 750 m (a and b respectively) and for the entire cast (c and d respectively).

$\theta$ -S diagram included in c.

Table 15: Listing of CTD data and derived quantities for station 9.

UC145	CTD 009	1984 027 1138Z			34 11.08N	69 59.02W	corrD: 5263m		
PRESS dbar	TEMP °C	SALIN psu	POTEMP °C	POTGRD m°C/db	SIGMA-t kg/m**3	POTDEN kg/m**3	BR-V cph	SSPEED m/s	DYNHGT dyn m
2.	19.254	36.425	19.254	0.00	26.062	26.055	0.00	1521.0	0.0000
6.	19.258	36.421	19.258	.11	26.058	26.051	-1.31	1521.1	.0078
10.	19.263	36.422	19.261	-.82	26.057	26.051	-.47	1521.2	.0159
16.	19.267	36.422	19.265	.21	26.056	26.050	-.87	1521.3	.0275
20.	19.268	36.421	19.265	.32	26.055	26.049	.39	1521.3	.0352
26.	19.277	36.425	19.272	-4.44	26.056	26.050	.39	1521.5	.0467
30.	19.269	36.422	19.264	3.72	26.056	26.050	.22	1521.5	.0549
36.	19.279	36.424	19.273	.23	26.055	26.050	.26	1521.6	.0667
50.	19.280	36.426	19.272	.27	26.055	26.051	.48	1521.9	.0942
66.	19.281	36.425	19.269	.81	26.055	26.051	-.11	1522.2	.1262
76.	19.283	36.425	19.270	-.68	26.054	26.051	.75	1522.3	.1459
100.	19.210	36.434	19.192	2.47	26.080	26.078	1.04	1522.5	.1936
126.	19.200	36.437	19.177	-.34	26.085	26.084	.68	1522.9	.2449
150.	19.192	36.435	19.165	-.23	26.085	26.086	.99	1523.3	.2926
200.	18.672	36.522	18.637	23.77	26.285	26.288	3.76	1522.8	.3893
250.	18.303	36.516	18.260	3.11	26.374	26.378	2.31	1522.5	.4776
300.	17.992	36.501	17.941	4.01	26.441	26.447	1.93	1522.4	.5636
350.	17.667	36.462	17.607	3.19	26.491	26.499	1.72	1522.3	.6477
400.	17.364	36.419	17.296	6.43	26.532	26.542	1.61	1522.2	.7300
450.	17.040	36.369	16.965	17.41	26.572	26.584	1.76	1522.0	.8117
500.	16.537	36.278	16.455	18.90	26.622	26.635	1.99	1521.2	.8918
550.	15.602	36.111	15.515	12.80	26.710	26.723	2.67	1519.0	.9692
600.	14.699	35.958	14.608	23.65	26.794	26.807	2.19	1516.8	1.0428
650.	13.803	35.813	13.708	37.76	26.874	26.887	2.94	1514.5	1.1127
700.	12.654	35.644	12.557	23.75	26.979	26.990	2.99	1511.4	1.1785
750.	11.357	35.470	11.260	28.45	27.094	27.103	2.71	1507.6	1.2389
800.	10.219	35.330	10.122	16.71	27.191	27.198	2.50	1504.2	1.2941
900.	8.163	35.158	8.067	28.84	27.393	27.397	2.63	1498.1	1.3906
1000.	6.885	35.112	6.787	6.30	27.543	27.546	2.21	1494.8	1.4682
1100.	6.058	35.085	5.956	8.70	27.633	27.635	1.77	1493.2	1.5341
1200.	5.538	35.076	5.430	-1.56	27.692	27.693	1.25	1492.8	1.5929
1300.	5.106	35.053	4.993	2.20	27.726	27.728	1.28	1492.7	1.6479
1400.	4.853	35.045	4.733	1.75	27.749	27.751	.91	1493.3	1.7003
1500.	4.680	35.040	4.552	3.65	27.765	27.768	.84	1494.3	1.7515
1600.	4.466	35.026	4.331	2.12	27.778	27.781	.74	1495.0	1.8018
1800.	4.189	35.011	4.038	.31	27.796	27.800	.67	1497.2	1.9002
2000.	3.950	34.999	3.783	.49	27.812	27.818	.66	1499.5	1.9973
2200.	3.783	34.995	3.599	2.29	27.826	27.833	.70	1502.2	2.0933
2400.	3.564	34.987	3.364	-.01	27.842	27.850	.60	1504.7	2.1877
2500.	3.458	34.980	3.249	-1.52	27.847	27.855	.69	1505.9	2.2344
2600.	3.340	34.971	3.124	.13	27.851	27.860	.60	1507.1	2.2808
2800.	3.145	34.956	2.912	.43	27.858	27.867	.61	1509.6	2.3727
3000.	2.970	34.944	2.720	1.22	27.865	27.875	.63	1512.3	2.4637
3200.	2.813	34.935	2.545	.21	27.872	27.884	.63	1515.0	2.5537
3400.	2.661	34.925	2.376	1.66	27.878	27.890	.60	1517.7	2.6423
3600.	2.513	34.916	2.209	1.01	27.883	27.897	.51	1520.5	2.7298
3800.	2.429	34.910	2.105	.80	27.886	27.901	.44	1523.6	2.8166
4000.	2.379	34.905	2.034	.07	27.886	27.902	.37	1526.8	2.9040
4200.	2.345	34.901	1.978	.15	27.885	27.903	.28	1530.1	2.9923
4400.	2.324	34.897	1.934	.30	27.885	27.904	.28	1533.5	3.0820
4600.	2.314	34.893	1.900	.10	27.882	27.904	.20	1536.9	3.1735
4800.	2.303	34.890	1.865	.27	27.880	27.904	.25	1540.3	3.2668
5000.	2.295	34.886	1.833	.61	27.878	27.903	.27	1543.8	3.3623

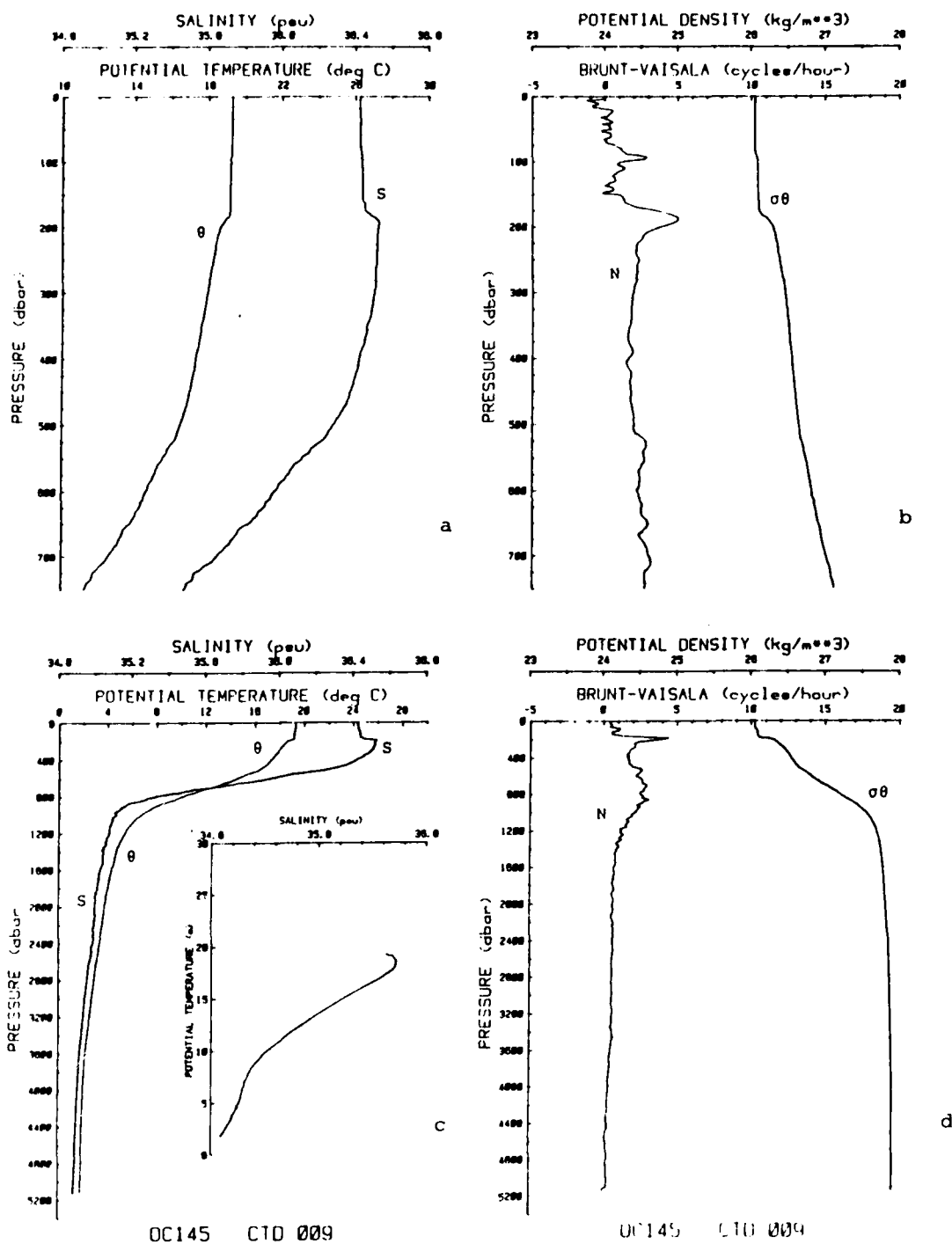


Figure 20. CTD station 9. Profiles of potential temperature ( $\theta$ ) and salinity (S), and Brunt-Väisälä frequency (N) and potential density ( $\sigma_\theta$ ) for the upper 750 m (a and b respectively) and for the entire cast (c and d respectively).  $\theta$ -S diagram included in c.

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## B. XBT Data

Expendable bathythermograph data were collected hourly (approximately every 20 km) along 70°W between 40°N and 34°N during the trip to the LOTUS area.

A Bathysystems digital logger stores the XBT casts at 1/10 second intervals (approximately every 60 cm) for later analysis. Using a Sea Data 12A reader with an ARI (asynchronous interface) to an HP85A, we transcribe, edit, annotate, smooth, and store the data in 2 dbar intervals on flexible discs.

The depths of the whole degree isotherms were transcribed from the strip chart records and plotted. Figure 21 is a chart showing the location of individual XBTs taken during the trip south. Figure 22 shows the XBT section from the southbound trip. Vertical exaggeration of the XBT sections is 1:463. Figure 23 is an overplot of all the XBTs made in the LOTUS area during OCEANUS cruise 145 (numbers 1-30). This presentation shows the range of temperatures observed due to the combined effects of the temporal and spatial variations.

All LOTUS XBT traces are supplied to the National Oceanographic Data Center for general access and usage.

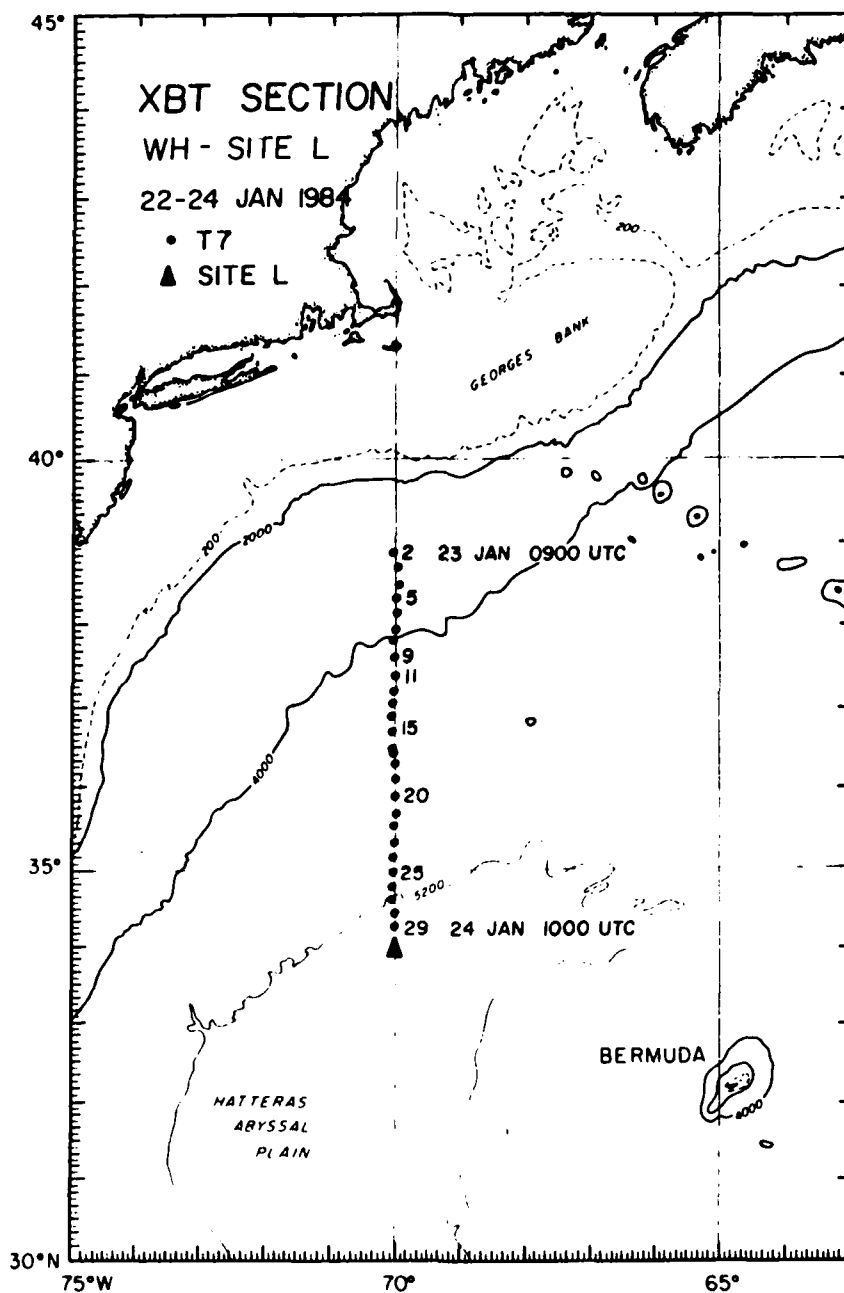


Figure 21. Chart showing the location of individual XBTs taken during the trip south to the LOTUS area.

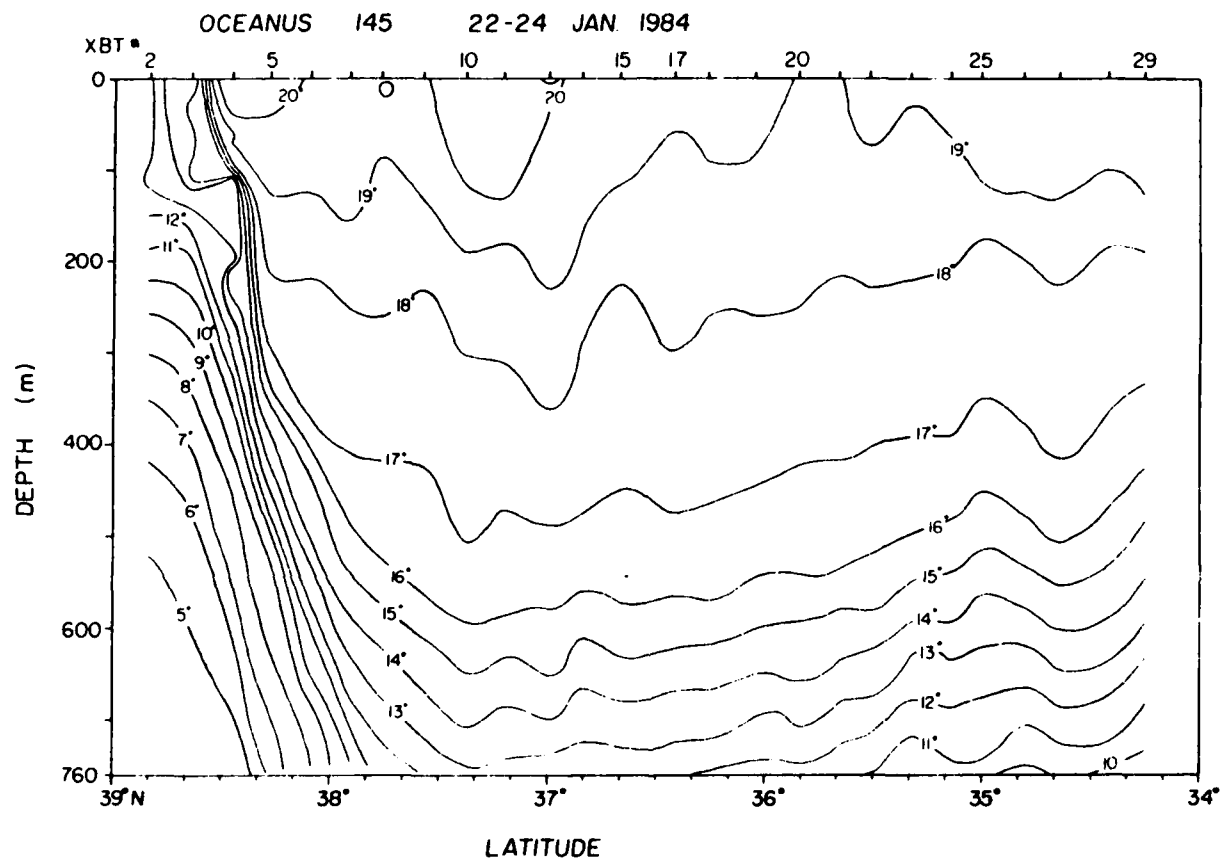


Figure 22. XBT section from the southbound trip along 70°W between 40°N and 34°N.

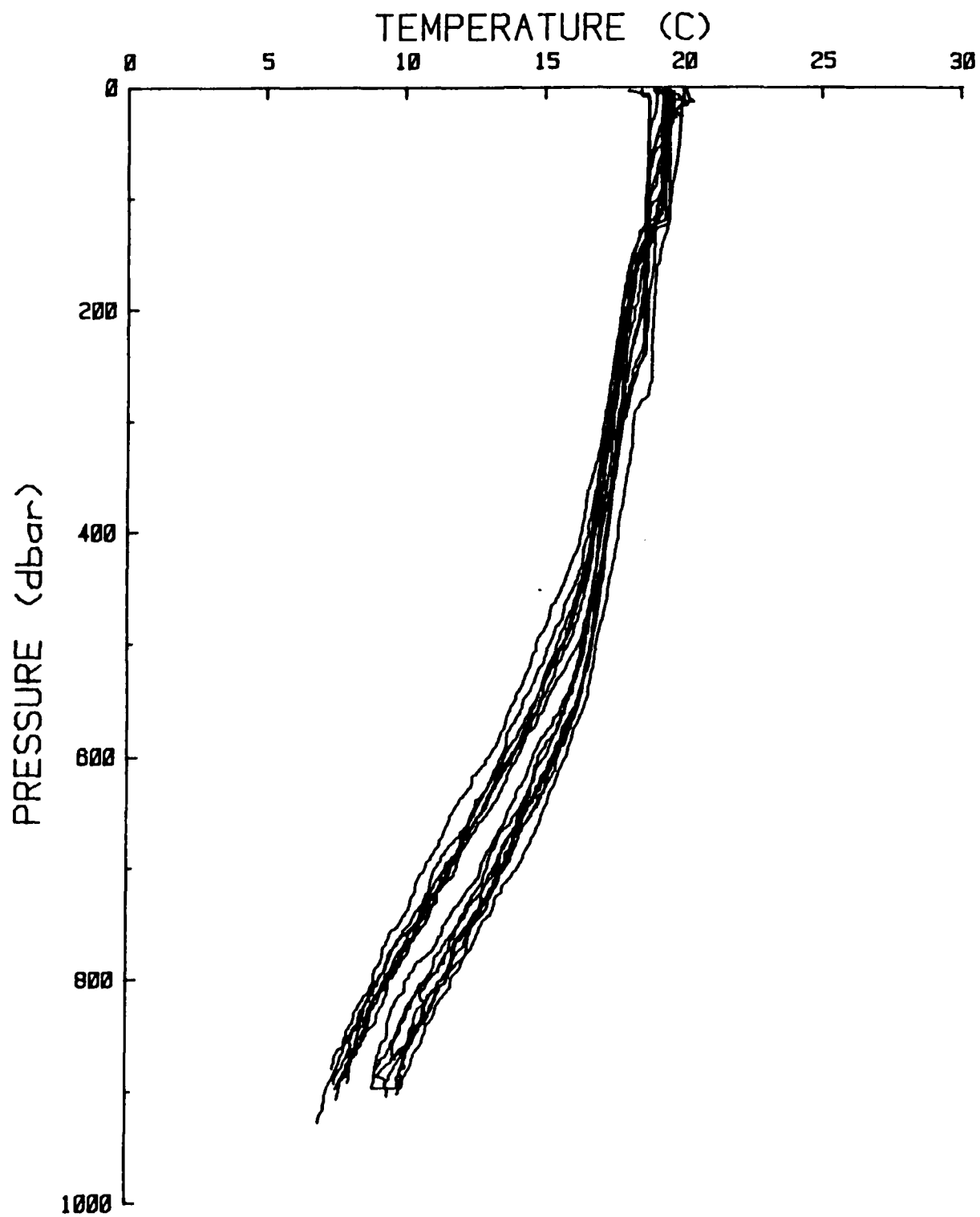


Figure 23. An overplot of all the XBTs taken in the LOTUS area during OCEANUS 145.

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APPENDIX I  
CHRONOLOGICAL SUMMARY

OCEANUS 141 (LEG 1)

28 October-4 November 1983

28 October - Day 301

1950Z : Leaving dock at Woods Hole. Winds 20-30 knots and forecast to increase.

2000Z : Weather awful. Science meeting to discuss options if it should prove impossible to work at the Gulf Stream site.

29 October - Day 302

0200Z : Not making much headway. After discussion with Captain we decide to press on however slowly and make our way down to the Gulf Stream site. Will probably lose a full day out of our program.

1200Z : Wind has dropped a little; now making 8 knots. Should arrive at the Gulf Stream site about 22 hours after planned time.

1515Z : First XBT on section toward GUSTO site.

1800Z : APOC calibration under way; XBT series suspended during calibration. Will attempt to increase frequency of XBT's as the shelf-break front is approached.

2045Z : APOC calibration run completed. XBT series to start again at 2100Z with No. 5.

2216Z : Gulf Stream north wall location received from NMN; plotted position shows us about 6 hours from it.

30 October - Day 303

0425Z : GDR paper not feeding properly.

0507Z : GDR up and running, also new paper installed.

0945Z : Beginning bathymetry line over Gulf Stream mooring site.

1211Z : Bathymetry line completed; back over site and putting hydrophone in.

1216Z : Timed pinger enabled.

1220Z : Range to mooring 4604 uncorrected meters. Corrected slant range about 4696 m, the water depth is 4688 m, the transducer depth is 5 m, and the release is 30 m off the bottom. This gives 631 m horizontal range.

1230Z : Move to begin the acoustic survey.

1250Z : Eastern point is 5218 m uncorrected slant range, 2818 m horizontal range.

1315Z : 6575 uncorrected or 5033 m horizontal range. This completes the survey with all crossings in the vicinity of 33°37.8'N and 68°02.7'W.

1355Z : 3693 m horizontal ranges; checks OK.

1410Z : Will do the first CTD station here, about 2 miles NW of the mooring.

1435Z : CTD #1 under way at GUSTO site. The deck is being rigged at the same time for the mooring recovery, including the removal of the bulwark on the starboard quarter.

1529Z : Messenger has switched ping-rate to double on CTD; rehaul commenced.

1638Z : CTD on board and secured inside; water samples taken. Move to anchor position to commence recovery.

1740Z : Good transpond at 4475 m uncorrected, or 340 m horizontal range.

1745Z : Timed pinger responds.

1751Z : Release command sent. Pinger responds.

1754Z : Top ball on surface, with working light but no radio, about a quarter mile north of us.

1838Z : Bottom ball cluster on surface.

1855Z : Top ball on deck and secured; first instrument aboard.

2018Z : Best-guess GUSTO position was 37°36.94'N, 68°00.07'W.

2058Z : Release onboard, mooring recovery complete.

2120Z : Head south to begin bathymetric survey.

2133Z : Turning to 070T (made good) to get the depth along the mooring's isobath.

2155Z : Turning back along the reciprocal course to get a long bathymetric line through the mooring site.

2300Z : Recommence XBT section on the way to Site L; XBT No. 27.

31 October - Day 304

1308Z : Dumping GUSTO wire from Pengo during transit to Site L.

1327Z : Wire dump complete.

1600Z : Last XBT (No. 47), 6 miles from Site L.

1706Z : Alongside LOTUS-5 and drifting; LORAN 7000 shows 250-260°T at 0.5-0.7 kts.

1728Z : Difficulties hearing 787 (LOTUS-5) release.

1754Z : Spare GDR installed and working better than old one; can hear transponder but not timed pinger.

1847Z : AMF 205 gives 5332 m slant range, or 1590 m = 0.86 n.mi. horizontal range.

1849Z : Release command sent.

1851Z : Release confirmation heard.

1955Z : Balls sighted; commence maneuvers for pickup.

2127Z : Eppley pyranometer glass hemisphere on LOTUS-6 broken by fish gaff while crew fishing during LOTUS-5 recovery. Spoke with Joe Poirier at WHOI on SSB (arranged by ham contact through phone patch from Maryland) to see about replacing it with the Eppley from LOTUS-5.

1 November - Day 305

0158Z : LOTUS-5 aboard and secured.

0300Z (approx) Zani and Briscoe switch Eppley pyranometer from LOTUS-5 to LOTUS-6.

0400Z (approx) Wire-test acoustic release for LOTUS-6.

0800Z (approx) Move to mooring 789 (East Intermediate) for acoustic survey.

0934Z : Commence acoustic survey of 789.



1150Z : Survey complete. Move to mooring 790 (South Intermediate).  
 1312Z : Finishing dumping wire from LOTUS-5.  
 1334Z : Commence acoustic survey of 790.  
 1529Z : Survey complete.  
 1620Z : CTD No. 2 begun at 790 site.  
 1926Z : CTD station complete.  
 2007Z : Move to LOTUS-6 launch point.  
 2113Z : New tape in Sea Data 1736 logger: 0.5 second sampling, 2048 samples 2<sup>h</sup> burst interval.  
 2158Z : Waverider buoy in water.  
 2252Z : Quick-release hook opened on LOTUS-6, dropping buoy to deck and damaging tower and meteorological instruments. LOTUS-6 launch aborted; Waverider recovered.  
 2313Z : Discussing options with Science party:  
     (1) Redeploy LOTUS-5 buoy with  
         (a) LOTUS-5 meteorological sensors  
         (b) LOTUS-6 sensors  
     (2) Move LOTUS-5 tower to LOTUS-6 buoy  
     (3) Abort deployment entirely.

#### 2 November - Day 306

0130Z : Deployment aborted: will wait until December or January to redeploy. Bring all gear back in lab and prepare for other work.  
 0315Z : Commence APOC calibration run.  
 0824Z : Calibration run completed. Return to 34°N, 70°W.  
 1318Z : Are in process of (a) preparing for a CTD station, (b) off-loading LOTUS-6 wire and nylon from the Pengo winch, (c) winding the PCM mooring onto the winch, (d) moving glass balls, and (e) repairing the crane wire (which jumped the drum during last night's problem).

Also, Gregory-Allen pointed out a NAV85 problem: either a smoothing algorithm or iteration/convergence problem means we do not get to the same geographical position from successive inputs of the same time-differences.

Will try and redeploy the Waverider during the APOC time-series later on, to give the wave field as originally planned.

1333Z : Commence CTD#3 at Site L.  
 1650Z : CTD #3 completed.  
 1708Z : Determining ship set/drift to choose PCM launch start position. The target is 34°00.71, 70°03.46.  
 1945Z : At start position for PCM. Set/drift is 315T @ 0.6 kts; wind approximately 045T @ 10-15. Will start from 33°50.61, 70°11.34, and steam 045T @ 1.6 thru water, or 033T @ 2.0 made good.  
 2000Z : PCM in water.  
 2300Z : Towing PCM to anchor point.

3 November - Day 307

0108Z : Will allow about 6% fallback, i.e. 305 m.  
 0113Z : Anchor in.  
 0151Z : Anchor on bottom.  
 0222Z : Commence acoustic survey of PCM anchor.  
 0345Z : Survey completed.  
 0412Z : Waverider in water on tether off port quarter. Putting CTD in water off block on starboard boom of the stern frame for a tow-yo series during the APOC time series.  
 0440Z : Waverider lost as a sudden squall drives ship down over tether. Radio signal apparently weak but still present. Commence search for buoy.  
 1043Z : Bridge reports visual sighting.  
 1053Z : Smashed Waverider floating at 33°58.73, 70°01.48.  
 1105Z : Buoy on board; obvious encounter with ship's propeller removed light and radio antenna. Apparently the signal we were tracking all night was not the Waverider.  
 1225Z : Underway to 789 (East) mooring for CTD station.

1300Z : Bridge requests cancellation of CTD station and direct transit to Bermuda; sound indicates something is either wrapped around the screw or there is a strut loose. If repairs in Bermuda are necessary we will need the time, and passage there cannot be at usual speed.

4 November - Day 308

1720Z : Dockside St. Georges, Bermuda, end of OCEANUS Cruise 141, Leg 1.

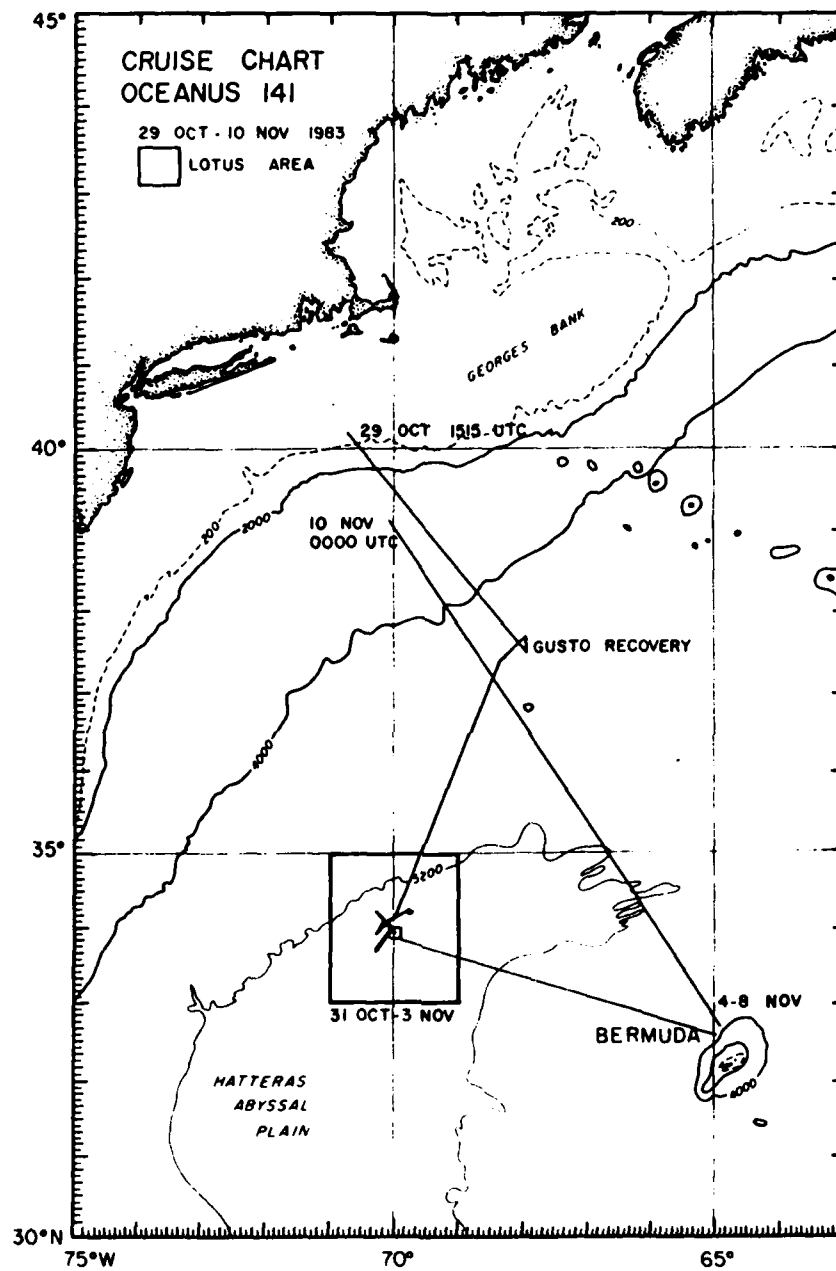


Figure A-1. Cruise track of OCEANUS cruise number 141.

APPENDIX II  
CHRONOLOGICAL SUMMARY  
OCEANUS CRUISE 145  
22-29 January 1984

22 January - Day 022

1815Z : Leave dock at Woods Hole, bound for 34°N, 70°W via 40°N, 70°W.  
1900Z : Science meeting in library.

23 January - Day 023

0400Z : XBT #2, first on 70°W section. (XBT #1 was a test at dock.)  
1600Z : High Seas Forecast (NMN/8765.4 kHz USB) suggests good weather at Site L for at least through Thursday (Day 026).  
2100Z : Fire and boat drill.

24 January - Day 024

1110Z : At Site L; will check set and drift.  
1147Z : Commence wire test of acoustic releases.  
1200Z : Drifting 313T at 0.8 knots; wind 10-20 knots from 112T.  
1308Z : Enabled release on mooring 788 and got slant range of 8.07 km, or 3.3 n.mi. horizontal range. Chart shows us about 3.5 n.mi. from mooring.  
1430Z : Started 1736 Wavelogger; first record will be at 1500Z. Set for 0.5 second sampling, 2048 samples, every 30 minutes. The strip chart is set for 10 minutes every 2 hours (even-numbered, Zulu), but the pen is almost dry.  
1445Z : Decision to deploy Waverider. One of the tethers was tangled, so will deploy just one rubber/wire-rope combination, with a wire-rope shot on either side.  
1451Z : Waverider in water trailing aft.  
1521Z : Top instruments on LOTUS-6 are over the side.  
1527Z : Speed increased to 1.5 kts thru water to help swing the buoy astern. P. Clay has installed the quick-release hook and checked it twice.

1533Z : LOTUS-6 in water, quick-release pulled. Perfect launch. The Waverider tether actually helped by keeping the buoy oriented alongship.

2010Z : Last shots of nylon; glass balls next. Making 1.8-1.9 kts thru water. 0.9 over bottom. Target 1.1 n.mi. away. Will assume 12% fallback, i.e. 0.35 n.mi.

2133Z : Anchor in. Buoy range 2.64 n.mi. at 315T.

2150Z : Close by buoy; Waverider riding well with rubber cord only slightly stretched.

2227Z : Begin survey of LOTUS-6 [mooring number 792] and 788 position.

25 January - Day 025

0050Z : Complete acoustic survey. Return to LOTUS-6 for CTD station.

0126Z : Commence CTD station No. 1 at LOTUS-6.

0250Z : Stopped lowering CTD; ship has drifted between surface buoy and anchor. Slow rehaul.

0408Z : CTD aboard without incident.

0542Z : CTD No. 2 commenced about 2 miles NW of PCM anchor position. Going down to 200 m.

0630Z : Finish CTD No. 2, moving 5 miles due south.

0730Z : CTD No. 3 to 250 m.

0755Z : CTD No. 3 completed.

0758Z : CTD crew assaulted by rogue wave.

0832Z : CTD No. 4 to 250 m.

0845Z : CTD No. 4 completed.

0915Z : Started to collect water samples for Celia Chen at URI.

1005Z : Water sampling complete.

1210Z : Alongside LOTUS-6.

1215Z : Waverider yawing  $\pm 25^\circ$  at the end of its tether.

1438Z : Commence anchor drag tests.  
1459Z : Abort drag test; tensiometer not functioning correctly.  
1609Z : Test releases on 789; some confusion on when timed release starts.  
  
Cannot demodulate the Waverider signal from this distance, only hear it.  
1614Z : Commence acoustic survey of mooring 789 position.  
1732Z : Complete survey.  
1831Z : Commence anchor drag tests.

26 January - Day 026

0122Z : Anchor drag test complete.  
0208Z : Real Time Profiler in the water for test.  
0407Z : RTP out of water. Made XBT profile No. 30 to check if RTP-identified hot patch (5°C) at 50 m was real. XBT did not confirm it.  
0532Z : CTD No. 5 at mooring 789 (East Intermediate).  
0815Z : CTD completed. Moving to 790 position (South Intermediate).  
1017Z : CTD No. 6 at mooring 790.  
1315Z : CTD completed.  
1350Z : Commence anchor survey for mooring 790.  
1507Z : Survey completed. Move to LOTUS-6 for RTP tests.  
1645Z : RTP in water.  
1736Z : LOTUS-6 2.48 n.mi. at 098T, by bridge radar.  
1800Z : RTP ascending at about PCM profiling speed; PCM about 3 miles away and theoretically ascending at the same time.  
2055Z : RTP aboard.  
2130Z : Have just circled LOTUS-6. Commence shallow yo-yo CTD series (No. 7).

2225Z : CTD No. 7 yo-yo complete. Head west for more CTD work and another anchor drag test.

2351Z : Commence anchor drag test.

27 January - Day 027

0635Z : Anchor aboard; test complete.

0650Z : Commence CTD No. 8 at western point.

1000Z : CTD on board and secured. Move to northern station.

1142Z : CTD No. 9 at northern station.

1446Z : CTD secured in lab. Steaming south to get Waverider signals.

1612Z : Corer in water.

1836Z : Corer on board and secured; apparently empty. Return to LOTUS-6.

1945Z : Have finished visual examination of LOTUS-6 and the tethered Waverider buoy during 4 m peak-to-peak waves, 34 knots wind. All seems normal except twice, at 1911 and 1941 there was a sudden drop in the Waverider frequency followed by a marked increase. The low-high combination indicates (from Waverider manual) a possible strong rotation (yawing) of the buoy, inserting turbulence into the fluid around the accelerometer platform.

1949Z : Moving to try a second core.

1955Z : Commence coring.

2213Z : Corer aboard and secured; empty.

2251Z : Steam for Woods Hole.

28 January - Day 028

0000Z : Last 1736 Wavelogger record.

29 January - Day 029

1412Z : Dockside Woods Hole.



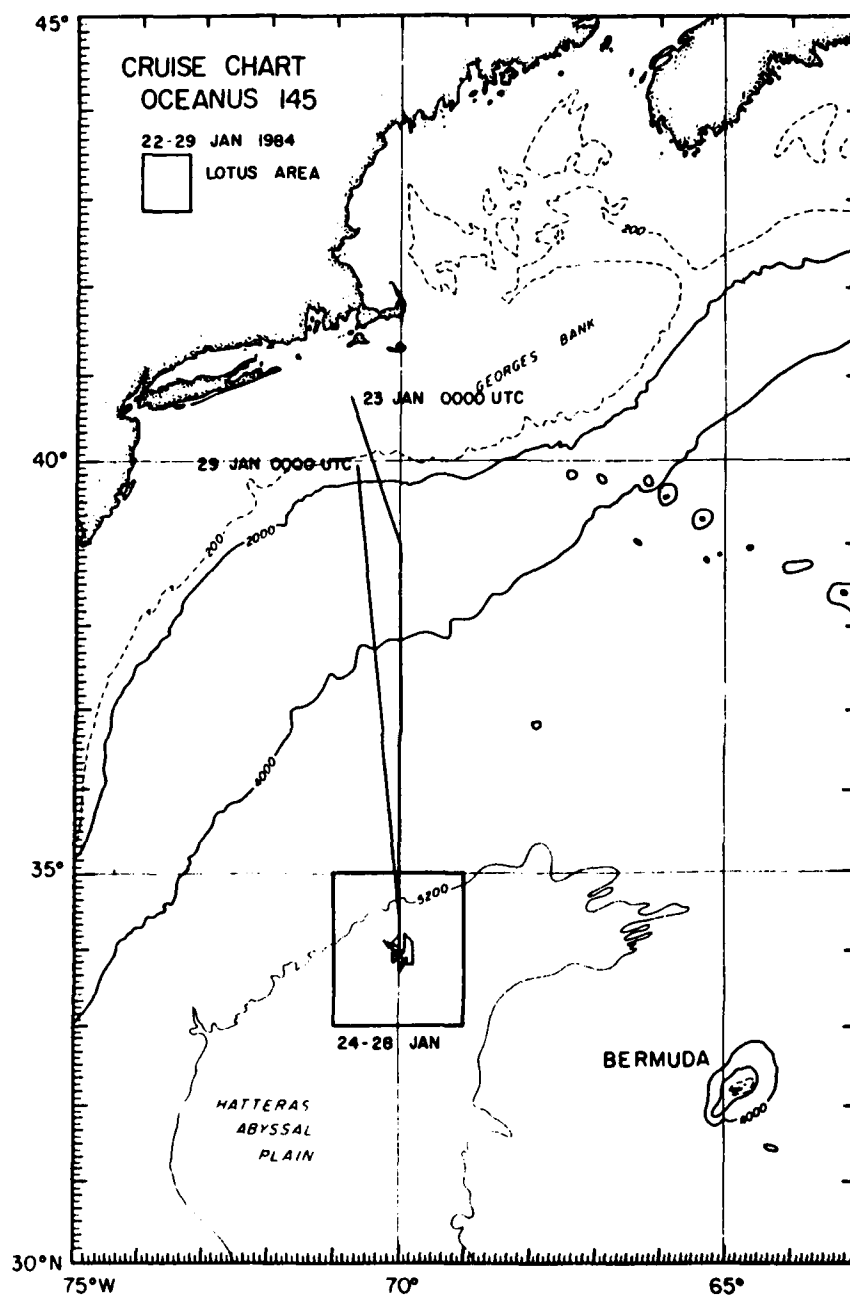


Figure A-2. Cruise track of OCEANUS cruise number 145.

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<b>16. Abstract (Limit: 200 words)</b>  OCEANUS cruises 141 (28 October - 4 November 1983) and 145 (22 - 29 January 1984) were the tenth and eleventh cruises to the Long Term Upper Ocean Study (LOTUS) area centered at 34°N, 70°W. During OCEANUS 141, a C. S. Draper Labs profiling current meter (PCM) was set, the fifth LOTUS surface mooring was recovered, and the deployment of the sixth LOTUS surface mooring was unsuccessfully attempted. The sixth surface mooring was finally deployed in January, on OCEANUS 145. This report provides details of the work accomplished on both cruises, as well as presenting the hydrographic data collected.			
<b>17. Document Analysis a. Descriptors</b> 1. LOTUS 2. Hydrographic data 3. Sargasso Sea  <b>b. Identifiers/Open-Ended Terms</b>			
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